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BRITISH RAILWAYS.

THE acquisition by the Government of the railways of the country is by no means a novel subject. It has been descanted upon in various journals, in the House of Commons, by Chambers of Commerce, and other public bodies with varying results. Again it has been brought under the notice of the House to be only somewhat summarily disposed of as a scheme not to be entertained.

The question is one which indirectly affects electrical circles. In acquiring the railways, the Government would along with them acquire the telegraph systems thereon, for to all intents and purposes these telegraphs at the present moment belong either to the railway companies or to the Post Office, for which department they are maintained by the companies. Such acquisition would place within the hands of the Government the entire telegraph service of the country —a result perhaps hardly to be desired. The public telegraph service is a monopoly for the benefit of the community at large, and we have no desire to cavil at the manner in which the work of the department is dealt with. At the same time, it cannot but occur that such a condition of things would place within the hands of the Government the monopoly of the manufacture of practically the whole of the electrical apparatus required for use in the country. By this we do not mean that the Government would of itself manufacture the articles, but that its selection, the description, form, and character of that which should be used would necessarily be determined by the official appointed to such duty. There would thus be an overwhelming inclination to form one groove and to regulate everything to that groove. That diversity of appliances which now attains on the various railway systems would be merged in a desire for uniformity, and the shape of that uniformity would be that of the mind of the individual controlling that branch of the subject. Such a condition would not, we think, be preferable to that which now obtains, and for this reason the proposal would not, we are of opinion, be hailed with delight by manufacturers generally. Viewing the question still further from this standpoint it will follow that such a change would bring with it less competition, and consequently less demand for all that is now found necessary for the conduct of that traffic which may, at the present moment, be regarded as the product of, or as being influenced by, healthful competition.

Whilst this is so, we, however, by no means share to the full extent the views expressed by the opponents to the resolution brought forward by Mr. Watt. We are quite in accord with Sir Michael Hicks-Beach that a Government has no right to enter into competition with private individuals merely for the purpose of profit. Nor do we assume for one moment if at any time the railway system should be acquired by the State that its acquirement would be undertaken with such an object. The object would, of course, be the cheapening of fares and rates, together with increased facilities for travelling. That under a united or individual management, free from competition, the railway service of the country is capable of being conducted far more economically than at present will be evident to every one who has devoted thought to the subject. Not only are the charges for management open to large reductions, but there are at present incurred enormous costs for canvassing which would be entirely swept away. So long as competition continues such charges must exist, and these, heavy as they now are, will probably increase rather than diminish. Savings would also present themselves in the reduced mileage worked consequent upon the abandonment of all competition. Take, for instance, the traffic between London and Manchester. There now exist no less than three magnificent train services between these points—the London and North Western, Midland, and Great Northern. The greater portion by far of this traffic is between the terminal stations. It cannot be doubted but that some of the trains which now form this competing service might be dispensed with, and the mileage saved. Many other similar instances may be found wherein similar economies might be attained. It is clear the cost of working may in many ways be reduced, but whether this could be effected, with regard to the cost of the undertaking, in such a manner as would make it remunerative is a question which requires very grave consideration. That the transfer of the railways to the State would be for the interest of the stock holders, and probably, also to the advantage of those employed or those otherwise connected with the services, we have little doubt. Nor would it be without benefit to the general public, inasmuch as the facilities for travel would increase, whilst it is probable fares and rates would be reduced.

In considering this question there is one more phase of it which calls for comment. The Government do not encourage the idea of State railways, and apparently they consider that the public interests may best be served by encouraging open and honest competition between the several systems; yet, on more than one occasion, the Government has shown an inclination to legislate on railway matters in such a direction as must eventually greatly depreciate railway property. The railways of the country were originally established under certain charters, or Acts of Parliament, which gave them powers as to rates and tariffs. If the Government now steps in, and by legislation enforces certain tariffs, it does appear that holders of railway stock—a very large proportion of the community—will have grounds for complaint that their property has not been treated with just consideration. In fact, that they have, as a class, been legislated against. And, if this is so, it

is clear that they will have reason on their side in demanding that the Government which has depreciated their property should take it into its own hands and administer it itself. All will agree that the enforcement of the adoption of those appliances necessary for the preservation of the lives and property of railway passengers has been a step in the right direction, but it has been a costly one for the railway companies. The cost has not, however, been begrudged. Railway companies have fully recognised the advantages of the block system, interlocking, and the automatic break, and many are proud of the advances they have been able to make in this direction. But interference with their rates and tariffs is quite another matter, and to many will appear as gross an interference with their vested rights as would be an Act passed to the effect that tradesmen should not exceed a certain price for certain goods sold by them.

That in discussing this matter under Mr. Watt's motion reference should be made to the acquisition of the telegraphs and to the unsatisfactory relationship which exists between the telegraph department and the telephone companies was but natural; but it does not appear to us that the position into which this question of the telegraph and telephone services has drifted should be allowed to influence the question of the railways, otherwise than to suggest that, where a monopoly is granted to a State department, it is eminently desirable that it should have, and exercise, the power of acquiring that which may come into competition with it to such an extent as to destroy the monopoly thus established for the public good. Had the Government acquired in the first instance the right to use the telephone for Exchange communications as an adjunct to the telegraph, as well as for intercommunication between place and place, it is impossible but to assume that the telephone service would have been as fully developed in this country as it is in America and elsewhere.

As mentioned last week several speakers during the A.T. *v.* B.T. discussion referred to the question of mains, and the general feeling was decidedly against placing a network of conductors at 2,000 volts underground for the purpose of feeding transformers situated in each house. Mr. Kapp, when reading his paper on transformers, said that if safety were to be considered the current for the lighting must be distributed from sub-stations by mains at a potential of 100 volts. Now Mr. Sellon, remarking on the experiences of the Brush Company with underground conductors, says that no sane engineer would lay down a complicated network of mains at 2,000 volts, since with a simple arc circuit the difficulties encountered are of the most discouraging kind. Mr. Stuart Russell, on the other hand, remarks that the difficulties hitherto experienced have been due to defective insulation, and that cables can now be made to stand perfectly well underground.

THIS question of mains, or rather its settlement, will influence in no small degree the future of electric distribution. Though there has been trouble with the insulation, we should be glad to think that this has been got over, the difficulties apprehended being not so much due to the insulation of the cable itself as to the conditions which would be entailed by a ramified system spreading in all directions, tapped at all points, and with hundreds of joints, and therefore hundreds of chances for incipient faults. There is all the difference in the world, as far as chance of breakdown is concerned, between a system in which few transformers are fed by few mains at a high difference of potentials and a system in which the charging mains really become the distributing mains as well, and feed a great number of small transformers with an extremely complicated network of conductors.

FOR insulation under the conditions present in underground telegraph conductors India-rubber has been tried and has failed. The history of the behaviour of underground cables carrying alternating currents of 2,000 volts has yet to be written. Though on this important subject we have all to learn, it would be strange if from difficulties met and triumphed over in the past we could obtain no guidance for the future.

OUR contemporary *Industries* thinks that the problem of electrical distribution, after all that has been said, remains pretty much where it was. Our contemporary also considers that the absence of remark during the discussion from engineers connected with the Grosvenor Gallery was somewhat strange. So did and so do we still.

WE are not disposed to accept at the moment Mr. Tomlinson's theory of the loss of magnetism in nickel and iron, though it is characterised by considerable ingenuity. It is worthy of note that Mr. Tomlinson considers the recovery of magnetism by iron at white heat explained by his theory, inasmuch as at the higher temperature the magnetic atoms are forced sufficiently far apart to cause an exhibition of free magnetism by the molecule.

A FRIEND tells us that he has much difficulty in finding any electrical or other firm willing to undertake the demagnetisation of watches, of which, he says, there are numbers requiring this little attention. He, himself, is in the peculiar position of being the recipient of numerous applications of the kind without being able to afford his clients any real assistance. From the result of our conversation we have come to the conclusion that there is a very good opening for some enterprising individual to turn his serious attention to this subject with every chance of securing a profitable return for his pains. The steel portions of first-class watches are very expensive to renew, whereas they might be demagnetised at the cost of a few shillings only.

STILL another friend appeals to us to put him in the way of securing a good electro-motor for dental purposes. He is connected with one of the largest firms of dentists in the metropolis, and although they have tried

small motors of well-known types which we need not here specify, there is still much wanting before electrically worked apparatus can be considered reliable and easily manipulated. A motor which is now being employed is driven by water, and its action is said to be eminently satisfactory, one of its best points being that it will stop *instantly*. This is very important in dental operations, but electro-motors have a very unhappy knack, at least so the patients think whose teeth are being bored, of giving a few extra revolutions after the current is cut off. Here again, we believe, is a large field for operation, if only a cheap, simple, reliable, and effective electro-motor can be produced to run at a very regular speed and which can be *instantly* stopped. Up to the present time no really serious efforts have been made to bring electricity into practical everyday use in such directions as we have indicated above, although the work which has been experimentally done has shown decisively that there are no insurmountable difficulties in the way.

WE notice in the *Warwick Times* of the 5th inst., that Mr. Crowther Davies has given notice that, at the next council meeting, he will move that the town clerk give 12 months' notice to terminate the contract for electric lighting of Leamington. We trust that there will be others forthcoming to oppose this motion, so that the promoters of this central station may have a fair opportunity of showing what can be done. It is to be hoped that by this time all the faults and little hitches which made the installation somewhat notorious have disappeared, and that nothing further will transpire to affect the regularity and certainty of the electric supply.

THE *Mechanical World* gives the following paragraph in its last issue :—"The cost of electric tram lighting in Germany is estimated, on an average of 2,100 working hours per annum, to be from 2s. 7d. to 2s. 10d. per light of 12½ candles per hour." Surely this should read 2·7d to 2·10d. ?

WE hear that another attempt is being made to float a company with a capital of half a million to work a primary battery. Whether the sum named is correct is a question which we cannot answer, but we are assured that the battery is that already known as the "Newton." Our readers may remember that we have already expressed our views respecting the merits of Mr. Newton's cell. Perhaps it may again be necessary to refer to it.

THE *Echo* is at it again, being probably influenced by the bad example of the *Times*. In reply to a correspondent the scientific representative of that worthy journal states his belief that in course of time electric lighting will be universally adopted, as it appears from figures recently published that it is cheaper than gas. When we inform our readers that the data quoted is that given some months ago by Mr.—or to give him his American title of Professor—Barrett, of Chicago, in his estimates for the lighting of that city, they will at once understand the value to be attached to the opinion of the *Echo*. It never seems to strike these gentlemen of the daily Press that gas in America is, on the average, three times as costly as in the United Kingdom.

WE regret to observe that the *Telegraphist* has run its final course, and that in this month's issue the editor bids farewell to his friends. The journal was the recognised organ of the postal telegraph operators in this country, and after a fitful career of a little over four years, it gives up the ghost primarily through lack of support. We cannot help associating this attempt to keep on foot a journal devoted to the interests of the large body of telegraph clerks, with that of the American *Operator*, which was so successful a venture as to become merged into the *Electrical World* of New York, now perhaps the most successful journal, pecuniarily, in the States. The reasons given in the "Farewell" for the dissolution of this interesting periodical are all sufficient, but we are nevertheless sorry that so little encouragewas given to keep it flourishing.

ON the evening of May 2nd, Prof. Blyth described to the members of the Glasgow Philosophical Society a practical experiment which he made last summer in the application of wind power to the production and storage of electricity. He gives the preference to wind power over that of water, and the results of his experiments are certainly of a nature to lead one to the belief that small windmills may yet be used to advantage in this direction. The details of his scheme may be seen in our "Notes" columns.

IT is not a little curious to note what progress the much abused so-called "Unipolar" dynamo, which is credited to the inventive genius of Mr. Ball, is making in the States. Here nobody would touch it, notwithstanding all that the courteous and genial representative of the Ball Company could say or do. Everybody knows that the peculiar form of the machine was the result of accident and not design, and that Mr. Ball chose to abide by the unlooked for result of his experiment. It appears that the machine is now amongst the most sought after of all on the other side.

ON Monday evening, April 23rd, at a meeting attended by all the available members of the Eastern Telegraph Company's staff at Carcavellos, Portugal, a handsome and valuable gold watch, bearing a suitable inscription, and accompanied by an address, was presented to Mr. Harwood. The watch is the joint gift of more than 60 of the Eastern Telegraph Company's *employés* who have served with Mr. Harwood at various periods during his 18 years sojourn, which dates from the opening of the station at Carcavellos. The presentation was made upon Mr. Harwood's resignation of the post of superintendent in the company's service, a step which appears to have occasioned general regret amongst the staff. With those who have signed the testimonial, we will add our wishes that Mr. Harwood may be long spared to wear the handsome present, which will serve to remind him in the future of the many genuine friends he has made by his numerous good qualities.

ON "FLASHING" CARBON FILAMENTS AT DIFFERENT TEMPERATURES.

By LEGH S. POWELL.

(*Continued from page* 471.)

SECOND SERIES OF EXPERIMENTS.

As has before been mentioned these experiments were conducted with greater care and attention to detail than those just completed. The principal additional observations and alterations effected were as follows :—

1. 60-volt 60-watt lamps were decided upon instead of those of 100-volt 60-watt, because the current, owing to its increased quantity, could be more correctly read in the former case than in the latter.

2. Instead of reducing the filaments to a given and equal resistance, each respective one was brought down 20 ohms cold whatever its resistance when mounted might be.*

3. The time in minutes and seconds occupied in each flashing process was noted as carefully as possible, instead of the approximate time.

4. During the process of exhaustion care was taken to keep the temperature low whilst incandescing the lamps.

5. All the filaments were proceeded with whether they were equal in weight after flashing or not.

6. The filaments were also examined under a microscope and the surfaces noted, but the observations are of but little value, for it frequently happens that one part of a filament will be far less perfect than another part, to say nothing of the difficulty of estimating comparisons, and under these circumstances it is impossible to be anything like accurate.

Experiment I.—Flashing at the Ordinary High Temperature in Gas.

As already mentioned, the original filaments selected for this series were thicker in gauge and shorter in length, the weight of each being ·0045 gramme, and they were flashed to 215 ohms cold. The next table gives the particulars and observations obtained with each respective filament at each stage of manufacture previous to the completion of the final lamp.

No. of lamp.	Time to flash in gas.	Quality of surface after flashing.	Weight of filament after flashing.	Resist. of mounted filament.	Reduced 20 ohms to	Time to reduce
	secs.		Grammes.	Ohms.	Ohms.	secs.
1	20	Ordinary	·0056	148	128	25
2	25	Ordinary	·0054	145	125	35
3	23	Not so good ...	·0056	132	112	30
4	20	Better than most	·0054	151	131	30
5	18	Ordinary	·0057	123	103	52
6	18	Not quite so good	·0057	132	112	55
7	19	Ordinary	·0053	156	136	20
8	22	Better than most	·0053	148	128	32
9	16	Ordinary	·0053	160	140	23
10	20	Not quite so good	·0056	148	120	27
11	18	Ordinary	·0056	143	123	25
12	18	Better than most	·0052	146	126	45
13	30	Not quite so good	·0056	150	130	25
Mean	20·5		·00548	145	125	32·6

* It was thought at the time of the experiments that this plan would overcome the confusion existing in the last series, but the fact was unfortunately overlooked that with a fixed fall, the proportional drop is greater in a filament of low resistance than in one which is higher. The error, however, is not very great in spite of the low resistance of the filaments, and, as will be seen in the "Discussion of Results," the circumstance proved in one instance rather an advantage than otherwise.

In this tolerably complete table there may be observed three distinct connections. One is between the weights of the filaments and their resistances, wherein those of low resistance are the heaviest and those of high resistance are the lightest. Another is between the weights and the noted aspect of the surfaces, the rougher ones being the heaviest and the smoother ones the lightest. The third is between the resistances and the lines to reduce, in which those of high resistance take a shorter time to fall 20 ohms in the reducing process than those of low resistance. The first and last of these connections help to prove that the errors in adjusting the resistance in this experiment are very considerable. We will, however, defer further discussion of these topics until later on, and now proceed with the experiment.

The next table gives the particulars of the lamps with the exception of Nos. 2 and 9 which sustained an accident.

	First Table.—Initial Reading.					Second Table.—Final Reading.					
					Calculated resist. hot.					Calculated resist. hot.	Drop.
No. 1	61 v.	·881 a.	15 c.p.	3·58 w.	69·2 ohms.	61 v.	·965 a.	18 c.p.	3·27 w.	63·2 ohms.	6 ohms.
„ 3	56 v.	·964 a.	15·5 „	3·48 w.	58·0 „	56 v.	1·02 a.	18 „	3·17 w.	54·9 „	3·1 „
„ 4	64 v.	·89 a.	16 „	3·55 w.	71·9 „	64 v.	·98 a.	19·5 „	3·16 w.	65·3 „	6·6 „
„ 5	55 v.	1·012 a.	15 „	3·70 w.	54·3 „	55 v.	1·09 a.	18 „	3·33 w.	50·4 „	3·9 „
„ 6	59 v.	·996 a.	16 „	3·66 w.	59·2 „	59 v.	1·071 a.	19 „	3·32 w.	55·0 „	4·2 „
„ 7	62·5 v.	·845 a.	15·5 „	3·40 w.	73·8 „	62·5 v.	·932 a.	19 „	3·06 w.	67·6 „	6·2 „
„ 8	61 v.	·863 a.	15 „	3·50 w.	70·6 „	61 v.	·97 a.	19·5 „	3·06 w.	62·8 „	7·8 „
„ 10	61 v.	·881 a.	15 „	3·58 w.	69·2 „	61 v.	·965 a.	18 „	3·27 w.	63·2 „	6·0 „
„ 11	59 v.	·87 a.	14 „	3·66 w.	68·9 „	59 v.	·97 a.	17 „	3·38 w.	60·8 „	8·1 „
„ 12	61 v.	·898 a.	15·5 „	3·53 w.	67·9 „	61 v.	·99 a.	19 „	3·18 w.	61·6 „	6·3 „
„ 13	64 v.	·932 a.	17·5 „	3·40 w.	68·6 „	64 v.	·996 a.	21 „	3·03 w.	64·2 „	4·4 „
Mean...	60·3 v.	·912 a.	15·4 c.p.	3·55 w.	66·5 ohms.	60·3 v.	·988 a.	18·7 c.p.	3·19 w.	60·8 ohms.	5·7 ohms.

A glance at the table of the cold resistances of the filaments will show that they vary very widely partly as above observed from errors in adjustment and partly, perhaps, through alterations in resistance subsequent to the flashing process. Therefore when we consider that they were not reduced to an equal figure, it is not surprising to find that the lamps are of very unequal electromotive force. Variation in surface may, however, still be detected as in lamps No. 6 and No. 11, thus proving that although they would no doubt have been more even with equal resistances, yet, like the more brightly flashed 100 volt lamps, they would even then vary considerably in electromotive force.

Experiment II.—Flashing at a Lower Temperature than the Ordinary One.

Similar original filaments were employed in this instance to those of the last experiment, but the temperature in the first flashing process was appreciably lower, and somewhat lower, in fact, than that employed in the corresponding experiment in Series I. The next table gives the particulars obtained.

No. of Lamp.	Time to flash in gas.	Weight of filament after flashing.	Resistance of mounted filaments.	Reduced 20 ohms to	Time to reduce.
	min. sec.	gramme.	ohms cold.	ohms.	
No. 1...	2 30	·0057	171	151	uncertain
No. 2...	2 25	·0059	accident	...	...
No. 3...	1 00	·0054	165 ohms	145	1 min. 0 s.
No. 4...	0 45	·0055	167 „	147	1 „ 35 „
No. 5...	1 30	·0061	159 „	139	0 „ 48 „
No. 6...	1 20	·0058	163 „	143	1 „ 10 „
No. 7...	1 15	·0056	168 „	148	0 „ 55 „
No. 8...	1 00	·0058	159 „	139	0 „ 55 „
No. 9...	1 30	·0055	165 „	145	0 „ 50 „
No. 10...	1 40	·0057	169 „	149	2 „ 00 „
No. 11...	1 35	·0058	166 „	146	1 „ 30 „
No. 12...	uncertain	·0056	163 „	143	1 „ 10 „
No. 13...	1 40	·0058	169 „	149	1 „ 10 „
No, 14...	1 35	·0058	164 „	144	1 „ 10 „
No. 15...	1 40	·0056	164 „	144	0 „ 35 „
No. 16...	1 40	·0059	176 „	156	0 „ 50 „
Mean ...	1 35	·0057	165·4 „	145·4	1 „ 6 „

The gauge of these flashed filaments, although not actually measured, was unmistakably greater than that of Experiment I. Their surfaces also were so equal and smooth in appearance after flashing that it was impossible to detect any definite variation between them by means of a microscope. This, it may be added, is the ordinary experience with slow flashing provided the surface is smooth to start with.

We see in the foregoing table that the filaments do not vary in resistance nearly so much as the more brightly flashed ones of the last experiment, which fact confirms in a conclusive manner the same result obtained in the last series of experiments in this respect.

In a comparison with Experiment I. we may observe some further interesting and important facts. One is a distinct increase in the average weights of the filaments. Another is a most marked increase in their resistance at the mounted stage, which result also confirms the experience obtained in Series I. A third fact is also disclosed here which was not shown in Series I., owing to the lack of the necessary observation, and that is the very great increase in the time occupied in the reducing process.

We will now pass on to the next table, which gives the readings of the lamps.

FIRST TABLE.—INITIAL READING.

					Calculated resist. hot.
No. 1	69 v.	·788 a.	14·5 c.p.	3·75 w.	87·4 ohms.
„ 3	64 v.	·788 a.	14 „	3·60 w.	81·2 „
„ 4	65 v.	·79 a.	14 „	3·66 w.	82·2 „
„ 5	64 v.	·826 a.	13·5 „	3·91 w.	77·4 „
„ 6	65 v.	·83 a.	13·5 „	3·99 w.	78·3 „
„ 7	67 v.	·78 a.	15 „	3·48 w.	85·8 „
„ 8	65 v.	·81 a.	13·5 „	3·94 w.	80·2 „
„ 9	65 v.	·807 a.	14·5 „	3·61 w.	80·5 „
„ 10	67 v.	·788 a.	13 „	4·06 w.	85·0 „
„ 12	65 v.	·83 a.	13·5 „	3·99 w.	78·3 „
„ 13	67 v.	·807 a.	14 „	3·86 w.	83·0 „
„ 14	67 v.	·826 a.	15 „	3·69 w.	81·1 „
„ 15	65 v.	·788 a.	14·5 „	3·53 w.	82·4 „
„ 16	68 v.	·788 a.	14·5 „	3·69 w.	86·2 „
Mean =	66 v.	·803 a.	14 c.p.	3·76 w.	82 ohms.

SECOND TABLE.—FINAL READING.

				Calculated resist. hot.	Drop.
69 v.	·915 a.	20 c.p.	3·1 w.	75·4 ohms.	12 ohms.
64 v.	·898 a.	18 „	3·18 w.	71·2 „	10 „
65 v.	·915 a.	18·5 „	3·21 w.	71·0 „	11·2 „
64 v.	·916 a.	17 „	3·45 w.	69·8 „	7·6 „
65 v.	·915 a.	17·5 „	3·39 w.	71·0 „	7·3 „
67 v.	·899 a.	20 „	3·01 w.	74·5 „	11·3 „
65 v.	·93 a.	18 „	3·35 w.	69·9 „	10·3 „
65 v.	·898 a.	18 „	3·24 w.	72·3 „	8·2 „
67 v.	·888 a.	16·5 „	3·60 w.	75·4 „	9·6 „
65 v.	·9 a.	17 „	3·44 w.	72·2 „	6·1 „
67 v.	·915 a.	19 „	3·22 w.	73·2 „	9·8 „
67 v.	·949 a.	21 „	3·02 w.	70·6 „	10·5 „
65 v.	·91 a.	19·5 „	3·03 w.	71·4 „	11·0 „
68 v.	·88 a.	17·5 „	3·41 w.	77·2 „	9·0 „
66 v.	·909 a.	18·4 c.p.	3·26 w.	72·5 ohms.	9·5 ohms

We see here that the average E.M.F. of these lamps is upwards of five volts higher than that of Experiment I., and the reason for this is owing to their higher resistance and not because they present a greater surface.

We may also observe that compared with Experiment I. the average fall in resistance which these lamps sustained is very appreciably greater. Having obtained evidence of this fact, viz., that flashing at a lower temperature promotes an increased fall in resistance in the finished lamp on its being run, the final experiment of this series, viz., flashing at a higher temperature than the usual one, was not proceeded with.

DISCUSSION OF RESULTS.

We will now give a list of the facts and inferences which appear to be proved by the interesting experiments above described, and then will proceed to examine more closely each respective result. It must be borne in mind, however, that these results are true with lamps made as described—*i.e.*, with smooth and equal original filaments, flashing in coal gas at the ordinary pressure, the final deposit of carbon from amyl acetate, &c.—and it does not follow that with other conditions in manufacture that the same experiences would occur.

First. *Surface.*—The process of flashing has the power to change unequally the surface of originally smooth and equal filaments, particularly when the temperature employed is high.

Second. Flashing at a comparatively low temperature is conducive to depositing carbon of smoother and more equal surface than at a higher temperature.

Third. *Weight and Resistance.*—If filaments are flashed at a comparatively high and equal temperature, those which happen to have the highest resistance will also have the least weight.

Fourth. *Weight and Surface.*—If filaments are flashed at a comparatively high temperature, those with the roughest surfaces will weigh the heaviest.

Fifth. *Weight and Temperature.*—Filaments when slowly flashed weigh heavier than when done more brightly.

Sixth. *Time and Reducing.*—Provided filaments are flashed at a high and practically equal temperature, those with the lowest resistance will take the longest times to fall a fixed number of ohms in the reducing process.*

Seventh. Filaments flashed at a low temperature take a longer time to fall a fixed number of ohms in the reducing process than those more brightly done.

Resistance and Temperature.—Eighth. Filaments change in resistance between the first flashing and the mounted stages. Those most brightly flashed will be the lowest, and those least brightly flashed will be the highest.

Ninth. Filaments slowly flashed are more even in resistance at the mounted stage than those done more brightly.

Tenth. Slow flashing in coal gas is conducive to a greater fall in resistance in the finished lamp than bright flashing.

Eleventh. The fall in resistance experienced by finished lamps is more even when the filaments have been slowly flashed than when more brightly done.

Surface.—It is clear from the evidence of each of the experiments, that in the flashing processes the surface of filaments can and does alter unequally, and we have also noted that the range of variation does not seem to be so great in the case of slow flashing as with bright flashing. It would therefore at first sight appear probable that a possible cause for this variation might be due to small differences in the temperature during flashing, since it is obvious that a moderately bright temperature may be more accurately hit off than a very bright one. But if this view were correct, we should obtain proof of it on comparing the different sets of lamps which were purposely flashed at different temperatures, and this proof we scarcely find. On the contrary we have evidence from the two experiments of the second series that the mean surface of both these sets of lamps is practically identical. This deduction may be drawn from the fact that at the same incandescence or watts per candle-power the amount of illumination is about the same in the "final" readings of the lamps. From another point of view, however, it is rather surprising that the slowly flashed filaments have not the larger surface of the two; for we have seen that in point of weight and size they have a distinct advantage, which fact would naturally imply a

* This result does not follow when the resistance is variable through changes which may occur subsequent to flashing.

greater extent of surface. But the reason for the equality would appear to be because the irregular and consequently increased surface of the filaments of Experiment I. is equal to that due to the increased mass and gauge of those of Experiment II. The first series of experiments does not help us very much from this point of view, owing to the different mean incandescence of each experiment. But we may examine them in a somewhat different light, and we shall see that the surfaces in Experiments I. and II. are nearly equal, whereas those in Experiment III. are slightly smaller. It so happens that the final mean resistance hot in each experiment is 157 ohms; therefore if the mean surfaces were all alike, we should have the same C.P. at 100 volts; but if they are different, then those with the smallest surface will be the brightest. If then we imagine the following mean readings at 100 volts, Experiments I. and II. would be about alike, but Experiment III. would be too bright.

Experiment I.	99 v.	·633 a.	18 c.p.	3·43 w.
Experiment II.	100 v.	·634 a.	20 c.p.	3·17 w.
Experiment III.	98·3 v.	·626 a.	18·8 c.p.	3·27 w.

It would almost seem that the surface in Experiment II. is slightly smaller than in Experiment I., and that therefore the experience of Series I. does not quite agree with that of Series II. in this matter: but the reason for this very slight variation is no doubt in consequence of the different amounts of carbon deposit which the respective sets of filaments received. With regard to the general resuls of this question of surface it would appear probable that with slow flashing on smooth, original filaments, you get a maximum bulk and weight together with a smooth surface: at a higher temperature the filaments have less bulk and weight but an increased surface, the result being that the two tendencies counterbalance one another about equally so far as the surface is concerned: at a higher temperature still a yet smaller mass and weight are obtained, but the surface is not rougher in proportion, and consequently the surface is smaller. So then our original surmise that the temperature of flashing might be a cause for variation in surface appears to be true in a measure, *i.e.*, when the temperature exceeds a certain point. That there are other and far more influential causes there can be no doubt, but what they are the present enquiry does not disclose. It has been thought that the differences in time the filaments take in the first flashing process had something to do with the surface, and when Experiment III. of Series I. was being conducted, filaments Nos. 1 and 2 were selected, the one as taking an exceptionally long, the other a very short time in that process. After the final readings had been taken these lamps were run at the same incandescence and gave the following tests:—

No. 1 =	97 v.	·585 a.	16·5 c.p.	3·4 w.
No. 2 =	93 v.	·575 a.	15·5 c.p.	3·4 w.

This direction seemed a promising one to follow further, but when we come to examine the shortest and the longest times to flash in the experiments of Series II. in this light we obtain very conflicting data.

Whatever causes this variation in surface it is evident that our practical lesson is that however important may be the desirability of obtaining even-sized original filaments (and no lamp maker will deny the importance of this policy), the difficulties in producing even lamps will be by no means overcome thereby, provided the subsequent flashing processes are conducted as in the present instance.

Weight and Resistance.—A decided and very natural connection is shown in Experiment I. of the Second Series between the weights and resistances of the filaments. It is obvious that if two equal filaments are flashed at the same temperature to two different resistances, the lower one will weigh the heavier of the two, and this is just what we find here. Thus by comparing the heavy weights with the light ones we obtain:—

Average of heavy filaments ·00563 gramme R = 139 ohms.

Average of light filaments ·00530 gramme R = 151 ohms.

Conversely:—

Average of low resistance filaments = 132 ohms weight = ·00565 gramme.

Average of high resistance filaments = 151 ohms weight = ·00533 gramme.

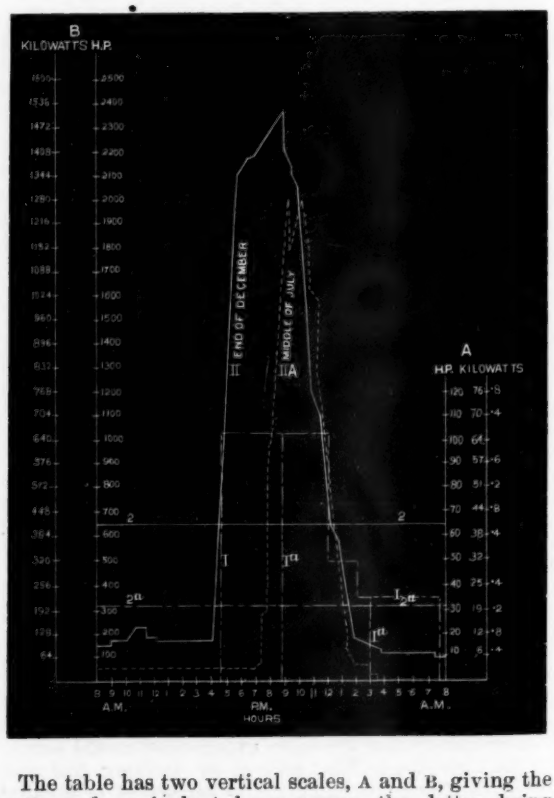
These figures show clearly that in this experiment the variation in resistance is owing to considerable error in adjustment rather than through any subsequent alteration, which we have seen may take place. Now Experiment II., on the other hand, does not show any similar connection between weight and resistance, and we may therefore deduce from this fact that the errors in adjustment in this case were not nearly so great. Series I. does not help us with this point, because a process of selection was adhered to and abnormal weights were rejected.

(*To be continued.*)

DIAGRAM OF PUBLIC AND PRIVATE LIGHTING IN BERLIN.

By KILLINGWORTH HEDGES.

THE following diagram has been calculated from the actual supply of a district supplied. It has been so arranged as to show at any period of the day or night the amount of light required, and has been calculated from data taken daily at one of the Berlin central stations. The calculations are based on the German equivalent of an electrical horse-power, viz., 640 watts to the horse-power instead of 746.



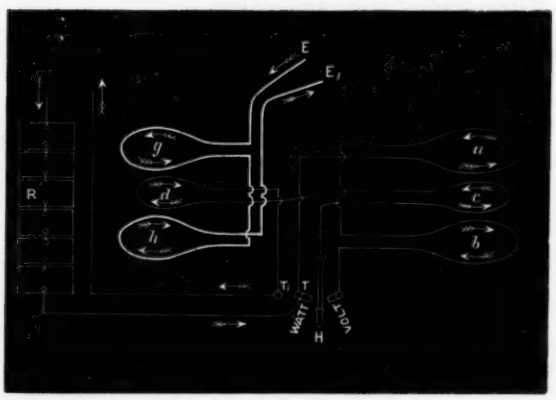
The table has two vertical scales, A and B, giving the watts and equivalent horse-power, the latter being drawn to ten times a greater scale than B, for the purpose of noting the smaller amount of lights required for street illumination. The horizontal line is divided into hours, and represents a day's lighting in the middle of December and the end of July, so as to show the maximum and minimum amount of current that will be required. In the lighting of a town there are two

classes of illumination, *i.e.*, the amount taken by the public, which is uncertain, and that employed in street lighting, which is a known quantity. The curves 2 and 2A represent the private lighting of houses, hotels, theatres, and shops of different kinds in December and July, the curve 2A being in dotted lines, clearly shows what a vast difference there is in the amount of light, and consequently the amount of energy required in the generating station, as compared with curve 2, which is taken when the days are shortest. The rectangles 1 and 1A show the street illumination, and are drawn to suit scale A; half-an-hour after sunset all the lamps are turned on, and the work reaches its maximum suddenly and continues the same until 12 o'clock, when, according to the municipal decrees, it falls in one or two gradations until half-an-hour before sunrise, when all the lamps are extinguished.

ON A NEW COMPOSITE ELECTRIC BALANCE.*

By Sir WILLIAM THOMSON, F.R.S.

THIS instrument has been designed for the purpose of providing, in one instrument, the means of measuring (*a*) the difference of potential between two points of an electric circuit, as, for instance, the difference of potential between the supply conductors of an electric light installation, (*b*) the current flowing in such a circuit, and (*c*) the rate of working in the circuit. The instrument thus forms a combined voltmeter, ampèremeter, and wattmeter. The general form of the instrument is similar to that of the standard centi-ampère or deci-ampère current balances, and it consists of (1) two coils of silk-covered copper wire fixed one above the other with their planes horizontal on a slab of slate, (2) two coils of similar wire made up in the form of anchor rings and fixed to the ends of a balance beam, (3) two coils fixed similarly to (1), but capable of carrying currents up to 500 ampères. The beam of the balance is suspended by two flat ligaments of fine copper wire



in such a position that one of the coils fixed to the ends of the beam is suspended midway between the fixed pair of fine wire coils (1) while the other suspended coil is similarly placed relatively to the thick wire, or current, coils. When the instrument is used for the measurement of alternating currents the current coils are made by two or three turns of a stranded conductor. Each wire of the stranded conductor is covered with silk so as to insulate it from the others, and, in order as far as possible to annul the effect of induction in causing the current to be different at different distances from the axis of the conductor, the strand is given one turn of twist for each turn round the coil.

The arrangement of the connections in the instrument will be readily understood from the figure, which shows diagrammatically the arrangement of the coils. In this figure *a* and *b* represent the fixed fine wire coils, *c* and *d* the suspended coils, and *g* and *h* the current coils. The instrument is joined in the circuit through a suitable anti-inductive resistance, R, through which the current passes to the terminal, T, from which the course of the current through the coils to T_1 is indicated by the arrows in the diagram, the switch handle, H, being in this case turned to "volt." For the measurement of ampères the switch is turned to "watt," a measured current passed through the suspended coils of the balance, and the currents to be measured passed through the coils, *g*, *h*, by introducing the electrodes, E, E_1, into the circuit. The current through the suspended coils may sometimes be measured by means of the instrument itself arranged for the measurement of volts. This may be done by first measuring the current which the difference of potential between the supply conductors of an electrical installation, or between the poles of a battery, causes to flow through the fine coils of the instrument and its external resistance, and then turning the switch to "watt," and, at the same time, introducing a resistance into the circuit equal to the resistance of the fixed coils. When the balance is used as a wattmeter the switch is turned to "watt," and the terminals, T, T_1, joined to the supply conductors, while the current through the circuit is passed through the coils, *g*, *h*. When the rate of working in an alternate current circuit is measured by such a balance, the anti-inductive resistance, R, must be so great that there is no sensible difference of phase between the currents flowing through the fine wire coils of the instrument and the electromotive force on the supply conductors to which they are connected.

* Abstract of a paper read before the Philosophical Society of Glasgow.

DURABILITY OF HARD DRAWN COPPER TELEGRAPH WIRE.

WE gather from the *Electrical Engineer* of New York that there has, within the last few years, been an enormous extension in the employment in the United States of hard drawn copper wire for telegraph and telephone purposes. At the commencement of 1884 there were only between 100 and 200 miles of this wire in use, whereas at present it is estimated that there are at least 50,000 miles, representing about 4,200 tons of metal, employed by the various telegraph and telephone companies.

The Baltimore and Ohio Telegraph Company was the first to extensively make use of this material, and their experience gained during 3½ years with it has proved that the many doubts as to the practical employment for overhead wires, of hard drawn copper, were groundless.

A table is given, formulated from half yearly tests and inspections, from which we take the following :—

Tests.	Gauge B.W.G. No.	Weight per mile, lbs	Diam. inches.	Tensile Strength. lbs.	Elongation per cent.	Ductility.	
						Bends on itself.	Twists in 6 in.
In factory ...	12	170	0·104	570·4	0·76	3	43·2
After nearly 4 years' service	,,	,,	,,	572·	1·28	3½	32·8
In factory ...	14	110	0·083	347·4	1·02	3	30·2
After nearly 4 years' service	,,	,,	,,	356·	0·93	3·1	33·6

The above figures are averages made up from specimens of wire taken at random from cities and the country, and from the neighbourhood of smelting and coke furnaces.

A STUDY OF CERTAIN ERRORS IN THE CONSTANT SHUNT METHOD.*

By WILLIAM L. PUFFER, S.B.

A VERY neat and valuable application of Ohm's law is that usually called the shunt method for the determination of current. The method is described in the Munich, Vienna, and Philadelphia reports on dynamo tests.

The principle is this: if a conductor of constant unknown resistance be placed in a circuit, and currents of different strength passed through it, there will be a difference of potential at the terminals of the conductor proportional to the currents flowing; and if this conductor be placed as a shunt upon a reflecting galvanometer whose resistance is high as compared with the conductor, and whose deflections are proportional to currents producing them, then the deflections will be proportional; first, to the currents in the galvanometer circuit; second, to the potential difference in the conductor; and third, to the currents in the conductor.

In order to extend the range of the apparatus, the galvanometer deflection can be kept the same by changing the total resistance in its circuit; then this total resistance is also proportional to the potential difference in the conductor. In order to save time, the galvanometer deflection may be nearly the same, and the product of the deflection and corresponding total resistance taken; these products will then be a measure of the corresponding currents in the conductor. If a known current be passed through this conductor or shunt, and the galvanometer deflection and total resistance of the galvanometer circuit multiplied, and the product divided by the known current expressed in ampères, we get the constant of the apparatus for ampères. To find value in ampères of an unknown current, we have only to note the deflection and total resistance in galvanometer circuit, multiply them, and divide by the constant. Or we could divide the known current by the product of resistance and deflection, and get a constant by which to multiply the resistance and deflection obtained with the unknown currents.

The range of the method is very great, and is, perhaps, limited only by the difficulty of making a suitable shunt of such a cross section as to be free from injurious heating by the currents used.

Wishing to employ this method in the Rogers Laboratory of Physics in a slightly different way, requiring that the shunt resistance be known, I made some experiments to determine the resistance of a German silver rod 3 feet long and 0·6 inch in diameter, with the intention of using it as a constant shunt of *known* resistance for currents from about 1 to 60 ampères. An inch from each end a small wire of German silver was silver-soldered in a hole drilled nearly through the rod, and the lead wires running to a low resistance galvanometer were connected by screw-clamps. On the ends of the shunt were soldered brass screw connection for insertion of the main wires.

A standard ohm was placed in circuit with the shunt by means of mercury cups and the resistance of the shunt found by comparison of the potential at its terminals with that at the terminals of the ohm, using a Hartmann dead-beat galvanometer and resistance box as usual with the shunt method.

The results were very unsatisfactory, although care had been taken to prevent, as far as possible, any error due to change in temperature, by placing both the shunt and the standard ohm in a water bath, and noting the temperature both before and after a set of readings.

As the observations were taken in a short time, and the resistances measured immediately afterward, it is not probable that there could have been any noticeable change during the experiment.

With the shunt in water, the results checked within about 0·3 per cent., the highest being 0·00 085 39, and the lowest 0·00 085 10 ohm. When the shunt was in melting ice the results were more variable, and in air very bad. A careful test of the wires and connection showed that when there was no battery in circuit, there was a variable electromotive force in both the galvanometer circuit and in the shunt itself, sufficiently great to account for the errors in previous work.

The error in the galvanometer circuit was avoided by greater care in manipulation and the use of a mercury commutator; but the shunt proved so troublesome that a study of the nature of the small disturbing electromotive force observed seemed desirable.

As this error, which I attributed to thermal action, was entirely negligible in the standard ohm because of the comparatively high difference of potential produced by the calibrating current, I thought that a German silver shunt, capable of carrying 5 to 10 ampères, having a resistance of from 0·1 to 0·2 ohm, might be compared with the ohm, and then with the shunt, without any appreciable error from heating or thermal action.

The following is a brief description of the shunts made, and the arrangements for taking observations and avoiding errors:—

The large German silver shunt has already been described. The standard German silver shunt was made of a 50-foot length of wire of $\frac{1}{4}$ inch diameter, drawn to order and of the quality known as "18 per cent." A short length of No. 14 German silver wire was looped around this shunt near each end and silver-soldered to it, using borax as a flux, and similarly a set of copper wires as well, thus giving me virtually two shunts of the same resistance and material, differing only in the metal wires used for the potential leads. The shunt wire was doubled and bent back and forth through porcelain insulators fastened to a piece of board. Also a copper shunt was made of two pieces of No. 00 wire, each 11 feet long; these were connected by being soft-soldered into a brass block, using resin as a flux, and then coiled in the same directions to avoid magnetic disturbance, and suspended from ebonite supports in a stone jar. At three places on this shunt—near each end and in the middle near the brass block—were soldered a set of four wires. Each set of four contained a German silver and a copper wire, silver-soldered with borax, and a similar pair soft-soldered with resin. This was equivalent to 12 simple copper shunts, with different leading wires and solders.

Each of these three shunts was placed in a tank of water provided with a thermometer. The potential wires were carried to mercury cups and commutators on a table 30 feet away, where the resistance boxes were placed.

The galvanometer was a double coil Hartmann, with bell magnet and copper damping-block; the deflections were read by a telescope and scale at a distance of 3·68 metres.

The galvanometer wires were soldered to amalgamated brass rods held in a piece of ebonite provided with a long handle, used in changing the connection from one set of wires to another.

In order to avoid temperature correction, the shunts were placed in water and carefully watched until it was evident there was no perceptible heating of the water or wires by the current. A loop of the galvanometer leads was always connected to a Wheatstone bridge used to measure the resistance in circuit. There was never any change large enough to cause any trouble, as the measurements were all taken in a short time, and the rise of temperature was very slow.

The deflections were always brought to about 10 double centimetres each side of the middle of the scale and were written 1,000, calling the tenth of smallest division unity. Within the limits of the scale the proportionality of the deflections was nearly perfect, and quite so within the limits of working. The error due to change in length of the suspending fibre was studied, and found to be negligible only when the precaution was taken to compare a mark on the mirror with a mark on the metal frame of the instrument, and adjust the height of the mirror to 0·1 or 0·2 millimetre. The

* Read at a meeting of the American Academy of Arts and Sciences, January 11th, 1888.

torsion of the fibre was negligible in the range of deflections used.

The galvanometer and its connecting wires had a resistance of 4·7 ohms, and was used as a voltmeter for measuring the thermal electromotive forces with an accuracy of about 5 per cent. The factor 0·00000040 was used to multiply the deflections by in order to obtain the thermal action in volts, when no resistance other than the galvanometer and connecting wires was in circuit.

It was assumed that these shunts would be calibrated with a current of 1 ampère, and that an accuracy of one part in 1,000 was desirable. The table gives the resistance of the shunts, and also the volts corresponding to an error of 0·1 per cent. of the difference of potential caused by a calibrating current of 1 ampère. These small electromotive forces are represented by 2 units of deflection of the voltmeter in the case of the copper and the large German silver shunts, and 2,000 with the standard shunt.

	Resistance in ohms.	0·1 per cent. P.D., due to an ampère.
Large German silver shunt ...	0·00 085	0·00 000 085
Standard German silver shunt ...	0·16	0·00 016
Half of copper shunt	0·00 070	0·00 000 070

The large G.S. shunt in air often showed from 1 to 3 units deflection, sometimes in one direction and sometimes in the other; but when placed in water this error was reduced to a much smaller amount, and seldom could be detected. At one time there seemed to be a variable deflection, which was traced to the contacts in the screw connection used to join the galvanometer leads to the shunt wires; this was easily removed by bending the wires until the clamps were under water. After this I could never detect any deflection caused by thermal action in this shunt, although owing to the low resistance of the shunt an error of 0·05 per cent. would cause so small a deflection that it might pass unnoticed.

The copper shunt, with its different terminals, proved very interesting, and exhibited a great variety of thermal action, which would, in many cases, be too large to be neglected if the shunt was to be used for comparison of currents.

The largest deflections were always found with the German silver wires, and the least with copper wires with soft-soldered connection. The deflections were seldom twice alike even with the same wires, ranging from 0·0 to 20·, being positive at one time and negative at others. The difference between the silver solder and the soft solder was not particularly marked, but seemed to be in favour of the soft solder, both with the copper and German silver leads. These deflections were always smaller and more regular when the shunt was in water than in air. It often happened that the copper soft-soldered leads gave no indications of thermal action, and I never saw any indication of trouble from the double-soldered connection in the middle of the shunt.

This shunt was made to correspond approximately to some of the shunts described in articles on the shunt method of determining currents both in regard to size and length of wire and method of connecting the lead wires.

The thermal action in the standard G.S. shunt was very much greater than in any part or combination of the other shunts, being larger when the copper leads were used by about 7 per cent.; still, even these large thermal E.M.Fs. were quite small when compared to that produced by the calibrating current, and could have been safely neglected if an accuracy of 0·1 per cent. was required. I thought I could now compare this shunt with the standard ohm easily enough; and then with the other shunts by using a current of several ampères, to get so great a difference of potential that the thermal effects would be drowned. I charged the storage battery, letting the current pass through all three shunts, and after a few hours I broke the circuit, and tested the shunts to see whether the current had perceptibly heated them, although a sensitive thermometer showed no change. The copper and large G.S. shunts seemed about as usual, but the standard gave me a deflection of 2,000, which rapidly diminished. This was far too small to be of any effect with this particular shunt, but it was very suggestive. Examination of the shunt showed a slight blackening at the positive end and a few bubbles of gas, probably due to slight decomposition of water, as the difference of potential had been about 1·8 volts. A reversal of the current caused the blackening to appear at the other end of the shunt, and a slight lessening of the discolouration produced by the previous current.

A current of 22 ampères in all three shunts produced 3·5 volts in the standard, and in breaking 0·00 06 volt at the end of half a minute, which fell to 0·00 000 2 at the end of five minutes. The deflection was in the same direction as when the current was passing, and was reversed by reversing the current. The other shunts gave no such effects even with 60 ampères, so work was chiefly on this shunt. A current of 45 ampères caused an effect which sent the spot off the scale for over a minute.

Curves were plotted, showing the diminution of the thermal effect at equal intervals of time after stopping the main current, which show that while the current is passing, the apparent resistance of the shunt is greatly increased by this action. It appears as if this counter electromotive force increased with the current, although not quite in the same proportion.

At this point my experiments had to be postponed, so all apparatus was put aside for a number of months, and then set up in exactly the same manner and position, with the exception that I only used the standard German silver shunt, to which I added three new sets of terminals—two of German silver and one of copper, all soft soldered, using acid for a flux.

Experiments were made to find what caused the variable deflection from this shunt after a current had been passing, and to see if there was any noticeable difference in the materials used in the potential leads and solderings.

I designated the different sets of leads in the following manner:—

Leads No. 1 were of German silver, soft-soldered.
" " 2 " Copper, "
" " 3 " German silver, "
" " 4 " Copper, silver "
" " 5 " German silver, " "

When the shunt was in air, the effects—due to thermo-electric action arising from the slight differences in temperature in shunt itself previous to the passage of a current—were found to be of such a magnitude as to be negligible in a shunt of such high resistance as this one, although far too great to be permissible in a shunt of a resistance corresponding to those generally used. These thermal electromotive forces varied both in sign and amount from zero to 0·00 000 12 volt, and having as an extreme variation about 0·00 000 24 volts. In this respect the German silver leads were anywhere from two to five or more times as bad as the copper, and the too soft-soldered ones seemed to be best, although not enough so to make any marked difference in the readings, which were very small at most. The difference between the copper leads was not appreciable.

With the shunt in air I allowed various known currents to flow for five minutes, and then took several series of readings every quarter or half minute for about five minutes or longer, if necessary, to see what effect was produced in the shunt by the passage of the current. When the currents were only two or three ampères there was no effect produced large enough to notice; and as I could readily detect an electromotive force greater than 0·00 000 04 volt the action, if any, must have been very small. With currents that produced a perceptible warming of the wire, I found a great variety of effects, differing even in the same set of leads at different times.

Curves were plotted, showing the effect produced by a current of 24·2 ampères in the shunt for five minutes. The sets of wires called No. 1 and No. 3 were made of the same piece of wire, and soldered at the same time with the same solder; and yet they vary in a very peculiar way, for which I have no explanation except that the composition of the German silver shunt has been acted upon by the solder used, and that in the short length (about two inches near each end), where the soldered joints are, the metal is not homogeneous.

The greatest deflection shows the electromotive force to have been 0·00 002 volt. Both sets of copper wires act in a similar manner, and give curves which rise quickly during the first half minute, and then gradually drop. Terminals No. 5 give a curve which begins high and falls sharply, and recovers slightly only to fall again. The curves of No. 3 fall rapidly at first, then rise in a regular and very marked manner, after which a fall takes place. Terminals No. 5 do not give especially marked curves unless it be on account of the much smaller deflections than any of the other wires.

I next placed the shunt in water, and examined it the next morning before passing any current through it, and found a large deflection of 105 units, corresponding to 0·00 004 2 volt. There was a slight difference between the various leads, generally about 5 per cent., but all deflections were in the same direction. I was careful to see that all parts of the shunt were under water, and that the soldered junctions were at nearly the same depth, but still the deflections remained. A current of 25 ampères was sent through the shunt to see if there would be a similar action to that when the shunt was in air, but upon connecting the galvanometer the deflection was entirely off the scale for five minutes, and lasted for an hour. I found that a current of less than an ampère in the shunt, but in the opposite direction, would reverse for awhile the remains of the effect due to the 25 ampères. There was no apparent difference in the leads, and as the deflections were reversible by reversing the current, and always opposite to those produced directly by the current, I concluded that there was an electrolytic action caused by the current. The positive end of the shunt always turned black, and the negative end tended to become white. I found that by carefully timing duration and direction of currents, I could get a right deflection which would diminish and a left one begin, which would in turn give way to another right deflection, but I was not able to get four changes. With the soldered ends entirely out of water the actions were exactly the same; but the moment the *whole* shunt was out of water all action ceased, and the deflection became very small; even 10 inches of submerged wire gave the deflection, though to a lesser degree, as did also a wet rag wrapped around the wire for a short length.

A current of less than an ampère would produce less than 0·2 volt at the terminals, yet I could get these effects by it, so that simple decomposition of the water was not the cause of the trouble, which it seems to me must be attributed to a "polarisation" effect. Having found the cause of the strange deflections when the shunt was in water, I did not continue the experiments any longer. The reason the large German silver shunt did not show such trouble is, probably, that it had been carefully shellaced when made, and was protected from the oxidising action.

In the light of these experiments, it seemed desirable to plan a shunt and galvanometer for use in comparing currents ranging from 1 to 1,000 ampères, which would not be affected by either thermal electromotive forces in its circuit or in the shunt itself. These data were assumed, and the galvanometer calculated.

Calibrating current to be 1 ampère.

Largest current to be 1,000 ampères.

Resistance of shunt to be 0·001 ohm.

E.M.F. at terminals when calibrating 0·001 volt.

Largest observed thermal E.M.F. 0·00 000 8 volt.

Average observed thermal E.M.F. about 0·00 000 08 volt.

Galvanometer current when calibrating to be less than 0·001 ampère.

Galvanometer coils to be 25 ohms of German silver wire.

Deflection to be 10 cm. at 1·5 metres, or about 2°.

Earth's field alone to be used.

Required dimensions of galvanometer.

The field due to the coils must be 0·006 in order to produce a deflection of 2° where H is 0·1717. The current producing this field would be 0·00 000 4 absolute unit; 25 ohms of No. 18 B. and S. German silver wire would be a length of 8,440 cm.

$$\text{Then radius of coil} = \sqrt{\frac{8{,}440 \times 0{\cdot}00\,000\,4}{0{\cdot}006}} = 2{\cdot}37 \text{ cm.}$$

$$\text{Average length of a turn} = 2\pi r = 14{\cdot}9 \text{ cm.}$$

$$\text{Number of turns} = \frac{l}{14{\cdot}9} = 566 \text{ or } 283 \text{ per spool.}$$

15 × 19 turns give a coil section 0·604 × 0·766 inch.

The galvanometer was made of a single copper casting, with two channels for the coils, 0·2 inch apart. Each channel was 0·77 inch deep, 0·61 inch wide, and had an inside diameter of an inch. If the galvanometer is much lower than 25 ohms, the variable plug resistance of an ordinary bridge will cause an error too great to be safely neglected when only the galvanometer, leads, and plugs are in circuit. The reasons for the other numerical figures are almost self-evident.

The shunt itself I would make of thin sheet German silver, with either copper or German silver end blocks, as was most convenient, but preferring copper. The lead wires to the galvanometer would be of copper, either soft or silver-soldered to the end blocks, and should go to a commutator very near the shunt itself, and the galvanometer circuit so arranged as to be easily disconnected from the shunt and placed in a mercury cup to close the circuit for the resistance measurement. I would prefer to measure the total resistance by a standard bridge always connected and kept at a constant temperature.

This kind of a shunt could easily be made so that there would be very little heating, and if shellaced, or protected from oxidation in any other manner, could be used in water, although some kind of oil would probably be better.

There should be suitable mercury cups arranged so that the current could be easily and quickly reversed in the shunt, or the shunt entirely disconnected from the circuit.

Rogers Laboratory of Physics, *January*, 1888.

ON THE HEATING EFFECTS OF ELECTRIC CURRENTS. No. III.

By W. H. PREECE, F.R.S.*

I HAVE taken a great deal of pains to verify the dimensions of the currents as detailed in my paper read on December 22nd, 1887,† required to fuse different wires of such thicknesses that the law

$$c = a\, d^{3/2}$$

is strictly followed: and I submit the following as the final values of the constant "a" for the different metals:—

	Inches.	Centimetres.	Millimetres.
Copper	10,244	2,530	80·0
Aluminium	7,585	1,873	59·2
Platinum	5,172	1,277	40·4
German silver	5,230	1,292	40·8
Platinoid	4,750	1,173	37·1
Iron	3,148	777·4	24·6
Tin	1,642	405·5	12·8
Alloy (lead and tin 2 to 1)	1,318	325·5	10·3
Lead	1,379	340·6	10·8

With these constants I have calculated the two following tables, which I hope will be found of some use and value:—

* Read before the Royal Society on April 19th, 1888.

† See ELECTRICAL REVIEW for March 9th, 1888.

TABLE SHOWING THE CURRENT IN AMPERES REQUIRED TO FUSE WIRES OF VARIOUS SIZES AND MATERIALS.

$$c = a\, d^{3/2}.$$

No. S.W.G.	Diameter. Inches.	$d^{3/2}$.	Copper. $a = 10,244$.	Aluminium. $a = 7,585$.	Platinum. $a = 5,172$.	Ger. Silver. $a = 5,230$.	Platinoid. $a = 4,750$.	Iron. $a = 3,148$.	Tin. $a = 1,642$.	Tin-lead alloy. $a = 1,318$.	Lead. $a = 1,579$.
14	0·080	0·022627	231·8	171·6	117·0	118·3	107·5	71·22	37·15	29·82	31·20
16	0·064	0·016191	165·8	122·8	83·73	84·68	76·90	50·96	26·58	21·34	22·32
18	0·048	0·010516	107·7	79·75	54·37	54·99	49·95	33·10	17·27	13·86	14·50
20	0·036	0·006831	69·97	51·81	35·33	35·72	32·44	21·50	11·22	9·002	9·419
22	0·028	0·004685	48·00	35·53	24·23	24·50	22·25	14·75	7·692	6·175	6·461
24	0·022	0·003263	33·43	24·75	16·88	17·06	15·50	10·27	5·357	4·300	4·499
26	0·018	0·002415	24·74	18·32	12·49	12·63	11·47	7·602	3·965	3·183	3·330
28	0·0148	0·001801	18·44	13·66	9·311	9·416	8·552	5·667	2·956	2·373	2·483
30	0·0124	0·001381	14·15	10·47	7·142	7·222	6·559	4·347	2·267	1·820	1·904
32	0·0108	0·001122	11·50	8·512	5·805	5·870	5·330	3·533	1·843	1·479	1·548

TABLE GIVING THE DIAMETERS OF WIRES OF VARIOUS MATERIALS WHICH WILL BE FUSED BY A CURRENT OF GIVEN STRENGTH.

$$d = \left(\frac{c}{a}\right)^{2\cdot3}$$

Current in amperes.	Diameter in inches.								
	Copper. $a = 10,244$.	Aluminium. $a = 7,585$.	Platinum. $a = 5,172$.	German silver. $a = 5,230$.	Platinoid. $a = 4,750$.	Iron. $a = 3,148$.	Tin. $a = 1,642$.	Tin-lead alloy. $a = 1,318$.	Lead. $a = 1,579$.
1	0·0021	0·0026	0·0033	0·0033	0·0035	0·0047	0·0072	0·0083	0·0081
2	0·0034	0·0041	0·0053	0·0053	0·0056	0·0074	0·0113	0·0132	0·0128
3	0·0044	0·0054	0·0070	0·0069	0·0074	0·0097	0·0149	0·0173	0·0168
4	0·0053	0·0065	0·0084	0·0084	0·0089	0·0117	0·0181	0·0210	0·0203
5	0·0062	0·0076	0·0098	0·0097	0·0104	0·0136	0·0210	0·0243	0·0236
10	0·0098	0·0120	0·0155	0·0154	0·0164	0·0216	0·0334	0·0386	0·0375
15	0·0129	0·0158	0·0203	0·0202	0·0215	0·0283	0·0437	0·0506	0·0491
20	0·0156	0·0191	0·0246	0·0245	0·0261	0·0343	0·0529	0·0613	0·0595
25	0·0181	0·0222	0·0286	0·0284	0·0303	0·0398	0·0614	0·0711	0·0690
30	0·0205	0·0250	0·0323	0·0320	0·0342	0·0450	0·0694	0·0803	0·0779
35	0·0227	0·0277	0·0358	0·0356	0·0379	0·0498	0·0769	0·0890	0·0864
40	0·0248	0·0303	0·0391	0·0388	0·0414	0·0545	0·0840	0·0973	0·0944
45	0·0268	0·0328	0·0423	0·0420	0·0448	0·0589	0·0909	0·1052	0·1021
50	0·0288	0·0352	0·0454	0·0450	0·0480	0·0632	0·0975	0·1129	0·1095
60	0·0325	0·0397	0·0513	0·0509	0·0542	0·0714	0·1101	0·1275	0·1237
70	0·0360	0·0440	0·0568	0·0564	0·0601	0·0791	0·1220	0·1413	0·1371
80	0·0394	0·0481	0·0621	0·0616	0·0657	0·0864	0·1334	0·1544	0·1499
90	0·0426	0·0520	0·0672	0·0667	0·0711	0·0935	0·1443	0·1671	0·1621
100	0·0457	0·0558	0·0720	0·0715	0·0762	0·1003	0·1548	0·1792	0·1739
120	0·0516	0·0630	0·0814	0·0808	0·0861	0·1133	0·1748	0·2024	0·1964
140	0·0572	0·0698	0·0902	0·0895	0·0954	0·1255	0·1937	0·2243	0·2176
160	0·0625	0·0763	0·0986	0·0978	0·1043	0·1372	0·2118	0·2452	0·2379
180	0·0676	0·0826	0·1066	0·1058	0·1128	0·1484	0·2291	0·2652	0·2573
200	0·0725	0·0886	0·1144	0·1135	0·1210	0·1592	0·2457	0·2845	0·2760
225	0·0784	0·0958	0·1237	0·1228	0·1309	0·1722	0·2658	0·3077	0·2986
250	0·0841	0·1028	0·1327	0·1317	0·1404	0·1848	0·2851	0·3301	0·3203
275	0·0897	0·1095	0·1414	0·1404	0·1497	0·1969	0·3038	0·3518	0·3413
300	0·0950	0·1161	0·1498	0·1487	0·1586	0·2086	0·3220	0·3728	0·3617

REVIEWS.

*The Practice of Galvano-plastics with Dynamos for the Purposes of the Graphic Arts.** By OTTOMAR VOLKMER. Vienna, Pest, Leipzic: Hartleben.

This work appears to belong to the "Chemico-Technical" Library of the enterprising firm, A. Hartleben, a companion series to the "Electro-Technical" Library, several volumes of which we have had occasion to notice. In the introduction we find mention of the curious fact that the ancient Egyptians practised the deposition of copper from solutions upon metallic and non-metallic objects, and that many specimens of their art have been discovered.

In the first section the author discusses the dynamos most suitable for galvano-plastic purposes, especially the systems of Gramme, Schuckert, and Krottlinger. As a motor he prefers the gas-engine of Langen and Wolff. It is noticed that Schuckert erects special machines for the deposition of nickel, whilst another kind is adapted for brass, silver, and copper. All these machines, along with the necessary appliances for measuring the current produced, are clearly described and figured.

* "Betrieb der Galvano-plastik mit Dynamo-elektrischen Maschinen zu Zwecken der graphischen Künste."

The second section treats of the laws of electrolysis, the electrolytic baths, their arrangement and working, and the results. In Section III. we find a description of galvano-plastic installations as now existing—that of the Imperial Military Geographical Institute of Vienna and that of the Imperial Court and Government Printing Works in the same capital.

In Section IV. the author passes to an account of the utilisation of galvano-plastics in the graphic arts. This subject resolves itself into two heads: operations with printing-plates already existing, but which require—*e.g.*, to be coated with steel, nickel, brass, or copper; and, secondly, the direct galvano-plastic production of a printing-plate. Under this head are included galvanography, stilography, galvano-caustics, glyphography, photogalvanography, &c.

The last section treats carefully, and with considerable detail, of the materials used in the operations and processes discussed in the foregoing sections. Cautions are given concerning the dangerous properties of some of the substances. We find it mentioned that the largest crystals of sulphate of copper (blue vitriol or blue-stone) are not, as it might be supposed, preferable. Small, irregular crystals are better for producing a solution of copper, as they dissolve more readily and render it easier to keep the liquid at a uniform strength.

As regards the water used in galvano-plastic operations, the caution is given that the presence of organic

matter and of chlorides is more to be dreaded than the bicarbonates of lime and magnesia.

At the end of this chapter we find a few directions for the treatment of poisoning cases which may occur in galvano-plastic establishments. The advice to pour cold water upon the head and spine if a cyanide has been swallowed, or if the vapours of strong prussic acid have been inhaled, is sound. We cannot say as much of the proposal to let a man who has inhaled chlorine gas or the fumes of oxides of nitrogen "drink as much milk as possible." According to our experience, small sips of the strongest vinegar or of dilute acetic acid are far preferable.

An appendix gives certain useful tables, such as specific gravities, solubilities, melting-points, &c.

This treatise will doubtless prove very useful to persons engaged in the arts and industries concerned.

Practical Education; treating of the development of memory, the increasing quickness of perception, and training the constructive faculty. By CHARLES G. LELAND, late Director of the Public Industrial Art School of Philadelphia. London: Whittaker & Co., Paternoster Square, E.C.

The continually increasing interest in technical education which is being shown is producing a large crop of literature bearing on the subject, though the particular field which Mr. Leland has gone over has not at present been widely surveyed. It would be somewhat difficult to give a proper idea of the contents of the work, which is partly a philosophical treatise and partly a book of workshop receipts. The author is, however, a complete master of what he writes about, and gives most valuable hints and information for those interested in pushing industrial art by means of training schools. He shows how every faculty is susceptible of cultivation, and gives interesting details concerning not only mind, but eye, memory, the lack of which so often causes an observer to omit to notice and recollect that there are two sides to the shield. The general contents of the book are as follows:—Part I. Industrial Art in Education; Design as a Preparation for Industrial Art-Work; General Observations. Part II. On Developing Memory. Part III. On Creating Quickness of Perception. Part IV. Eye-Memory. Part V. Taking an Interest; Conclusion. Appendix I. Karl Werner on the American System of Art Education in Schools. II. Report of the Commissioner of Education in the United States on the Leland School in Philadelphia. III. The British Home Arts and Industries Association. IV. A List of Principal Works on Technical Education. In conclusion, we can recommend Mr. Leland's book as being both interesting and instructive.

Researches on Diamagnetism and Magne-Crystallic Action; including the question of Diamagnetic Polarity. By JOHN TYNDALL, D.C.L., LL.D., F.R.S., New Edition. London: Longmans, Green & Co.

In this new edition of his well-known work the author has aimed at rendering the volume small and handy by omitting various topics which were introduced in the first edition. In the preface the conclusions of Plücker with reference to the magnetic and optical deportment of a crystal are criticised, and the question of diamagnetic polarity and Weber's theory of the same referred to; the results of experiments recorded in the author's "Fifth" Memoir conclusively showed that the various objections raised against Weber's own results were groundless.

Kalender für Electrotechniker, 1888. By F. UPPENBORN. München und Leipzig: Druck und Verlay von R. Olderbourg.

This book is very similar to the well known work of Munro and Jamieson, though framed on German lines, *i.e.*, in cases where apparatus is referred to the German patterns, &c., are mentioned and illustrated. It is decidedly well got up.

OBITUARY.

CHARLES TILSTON BRIGHT.

IT has been our painful duty to record too often of late the passing away of some well known name whose mark has been firmly made in the as yet but brief history of the electric telegraph. It was but the other day we chronicled the demise of Crampton, whose name was so intimately associated with the first submarine cable that connected these shores with France, and now we have to record the death of Sir Charles Tilston Bright, whose name is indissolubly connected with the first Atlantic cable. Sir Charles was taken suddenly ill whilst staying at his brother's on Thursday week last, and died of heart disease.

Sir Charles Bright was the youngest son of Mr. Brailsford Bright, of Wanstead, by Emma Charlotte, daughter of Mr. Edward Tilston, and was born at Wanstead in 1832, so that at the time of his death he was but 56 years of age. He was educated at Merchant Taylors' School, and he showed special scientific aptitudes very early in life, his attention being particularly directed to chemistry and electricity.

Charles Bright, who had become acquainted with the late Sir Wm. Fothergill Cooke, was, in 1847, when he was about the age of 15, introduced into the service of the Electric Telegraph Company, at that time established to work the patents of Cooke and Wheatstone. This company was compelled for various reasons to purchase many patents, amongst which was the chemical printing telegraph of Bain. Lately Sir Charles spoke of this instrument:—"I myself often saw, in the year 1847, Bain's telegraph working at an astonishing speed between Manchester and London, and have never been able to understand the cause of its being abandoned." These remarks were made in his inaugural address in January, 1887, as the newly-elected President of the Society of Telegraph-Engineers. The election of Sir Charles Bright on the occasion of the Jubilee year of the Telegraph, as well as in the Jubilee year of the Queen, may be taken as an especial compliment to one who had worked so hard to promote the interests of telegraphy. So identified has been his career with the step-by-step motion of the telegraph, that in his remarks dealing with the history of the telegraph it was impossible for him to avoid mentioning the part he personally played in the advancement and progress of the science; to have omitted his own name would of necessity have caused various blanks in the narrative. The address of Sir Charles Bright, coming so short a time before his sudden and early demise, gives it all the character and force of an "autobiography." As such we are glad to accept it so far as it goes, and from it we shall quote, in furthering our object of following the history of the late President.

From 1847 he was engaged in engineering construction work with the Electric Company until about 1850, when for a short time he was connected with the British Company. The year 1850 was notable in the history of the Company (Electric), because, owing to its high tariffs, a clamour arose for competition, and in that year Acts of Parliament were granted to the Magnetic Telegraph Company and to the British Electric Telegraph Company, which afterwards amalgamated under the name of the "British and Irish Magnetic Telegraph Company," generally known as the "Magnetic Company." He then joined the Magnetic Company, of which his brother, Edward Bright, had been appointed manager.

Immediately on his appointment with this company he was engaged with great success in constructing new lines of overground telegraph. In 1852 he was appointed engineer to the company, and at this time he was occupied in carrying out a most extensive scheme of underground wires between London, Manchester, Liverpool, and other places. The Electric Telegraph Company having secured the monopoly of erecting wires on the principal railways of the kingdom out of London, the Magnetic Company carried out, under the

superintendence of Charles Bright, a large amount of underground work, in addition to overhead lines on some of the Northern Railways. Sir Charles speaks of this portion of his work: "Such of the railways in Great Britain as had not been exclusively secured by the Electric Company were eagerly arranged for by the new company (Magnetic), and nearly all in Ireland, which had not been thought worth attention by the Electric Company. In this way competing lines were established on the Lancashire and Yorkshire, East Lancashire, Leeds (Northern), Newcastle and Carlisle, Glasgow and South-Western, and throughout Ireland. To connect up with London, the Magnetic Company laid a line of ten wires in troughs, along the high road by Birmingham to Manchester and Liverpool, *via* Wigan, continuing six wires to Preston, Carlisle, Dumfries, and Glasgow, with a fork from Dumfries to Portpatrick." These lines were laid partly by the Company's staff, and the rest by Messrs. Reid and Mr. Henley. The great underground system comprised 6,348 miles of wire. All this work, both overground and subterranean, entailed a vast amount of energy and perseverance on the part of Sir Charles Bright, and many are the stories related of the difficulties overcome in the rapid progress of the underground work. Details of these works have been sufficiently published in various papers, but we may mention that it was but a short time since that in disturbing the ground in the main street in Manchester, some of the old iron troughing was found in excellent condition.

It may be mentioned that perhaps the first work which brought Charles Bright into public notice was laying underground the Manchester telegraph lines under the streets of that vast city in one single night without disturbing the traffic. This he performed at the age of 19, so that it will be seen he began active work early. There was a leading article in the *Times* at the time extolling Charles Bright for this first great achievement.

The underground cables gradually failed, and as a section went bad, it was replaced by an overhead line, until the whole vast scheme of underground work had disappeared, not however until it had proved of great value and of incalculable advantage, as by the means of the long underground lines coupled together, it was possible to connect up a line of sufficient length to prove incontestably that telegraphic communication could be carried out underground through a distance exceeding that between this country and America.

The extension of the Magnetic Company's system throughout Ireland was in connection with the successful submersion of a submarine cable of six wires between Portpatrick in Scotland and Donaghadee in Ireland. This was in 1853, and this was the first occasion on which Charles Bright took a part in the submergence of a submarine cable. We may remark here that Charles Bright continued as engineer-in-chief to the Magnetic Company until 1860, when he became consulting engineer, a position which he held until the acquisition of the telegraphs by the State in 1870. Before proceeding to mention that period of his career with which his name is so inseparably connected, we must not omit the many inventions and improvements introduced by him into the working of the telegraph. His name occurs frequently in the patents record, and there are but few who are not familiar with Bright's insulators and shackles, and especially with the acoustic telegraph—so generally known and so largely adopted and still in use—commonly called "Bright's Bells." The first patent taken out by Charles Bright, in connection with his brother, was on 21st October, 1852—when he was but twenty years old—for "Improvements in making telegraphic communications, and in instruments and apparatus employed therein and connected therewith."

Amongst these improvements will be found a special system for testing insulated conductors, with the object of localising the distance of an earth or contact from a station, by the use of a series of resistance coils mounted in a box. This is the first mention of resistance coils specially constructed of different values to be met with, and the credit of the first to use this system of testing rests entirely with the late Sir Charles Bright. The same patent mentions a standard galvanometer, which appears to foreshadow differential testing. The introduction of "shackling" off wires is also covered by this patent, and the system thus tried for the first time to meet the especial requirements of cutting and terminating wires has been carried out in substantially the same manner ever since. A novel arrangement of lightning conductor, with the uses of "an exhausted air-tight glass box" shows that at that early date the effects of lightning in telegraphic work were disastrously felt. A repeater or translator for relaying and re-transmitting electric currents of either kind in both directions forms one of the claims. Whilst a "type-printing telegraph," a "centrifugal alarum," "winding coils for telegraphic purposes," form claims, the 12th claim is for "causing mercury to effect metallic contact by compressing it in a closed vessel by means of air, &c., the points with which it is desired to make contact being within the vessel. The same patent also contains methods of insulating subterannean and submarine wires; in the former plan we find that mention is made of "wires protected by a helically-wound riband of iron," a remarkable instance of foresight as to the class of sheath required for an insulated conductor.

It is stated that in the year 1854, Charles Bright and his brother were engaged in experiments with the late Mr. Staite (whose name in connection with electric lighting has lately been brought into prominence by his son) in the electric light, which was exhibited nightly on the landing stage at Liverpool. We also learn that during the same year Charles Bright devoted some time to experiments on dynamic electricity with Mr. Soren Hjorth, who constructed a dynamo machine.

During the time we have been speaking of, and subsequently, the principal instrument in use by the Magnetic Company was Henley's magneto-electric telegraph, used either as a "single needle" or a "double needle." It was indeed the sole adoption of this instrument which gave the company its name. This system of telegraphing by means of visual signals necessitated the constant and fatiguing attention of one telegraphist, whilst a writer was required to take down the words called out by the receiving operator as he read off the signals forming words. The substitution of aural signals for visual was contemplated by Charles Bright as a manifest and great improvement in signalling; and in conjunction with his brother, after numerous experiments, they took out a patent which, amongst other things, specially included what is universally known as "Bright's bells." The patent is numbered 2,103, September 17th, 1855, "Improvements in electric telegraphs, and in apparatus connected therewith." This invention "consists of improvements in the electric telegraph complete," in which sound is employed as the communicating medium instead of visual indications. "A complete electrophonetic telegraphic instrument" (says the abridgements), and its necessary arrangements consist of the following parts:—

1. The apparatus for and method of transmitting signals.

2. The receiving relay, which has the means of increasing its sensitiveness, and of protection from the effects of return currents.

3. The "Phonetic," a sounding apparatus; this "may be either used separately as a complete instrument, or applied in part to other telegraph instruments now in use."

Instead of describing the arrangements we need but refer to the following: "the magnet, when acted on by electro-magnetic coils, causes the axle to vibrate or deflect in one direction, thus sounding a bell by means of a hammer head on one arm; the subsequent reversal of the electric current causes a 'muffler' on the other arm to stop the sound."

It must be noted that this patent includes an arrangement "for enabling signals in opposite directions to be

made simultaneously," a plan, which we are told, was worked successfully between London and Birmingham. In this specification will also be found very interesting details for producing working currents by means of "induction coils." The patent including "an apparatus for obtaining a nearly continuous current from currents induced in secondary coils by the action of a quantity galvanic battery in primary coils." It will be seen from an examination of these several patents what a large practical and scientific field Charles Bright covered as the result of his experience, his intuitive knowledge, experimental investigation, and his foresight as to the requirements of telegraphic science. We might enter more fully into the details of these various inventions, but sufficient has been shown of his wonderful insight into the mysteries of the profession he was so largely following.

We now come upon that period of his investigations and experience which led directly to the great work with which we have mentioned that his name is inseparately connected. To mention the Atlantic cable is at once to bring the name of Sir Charles Tilston Bright before us. During the time that the underground system of wires was growing under his hands, Charles Bright was carrying out numerous experiments as to the effects of the transmission of signals through long distances. And some of these experiments were detailed in a paper read by Mr. Edward Bright on "The retardation of electricity through long subterrannean wires" before the British Association at their meeting at Liverpool in 1854. It may be mentioned here that in 1849 Werner Siemens observed the electric charge in underground line wires, and that in 1852 Latimer Clark noticed the phenomenon of the slow transmission of electric currents through submerged wires. Whilst, in 1854, Professor Faraday communicated two papers on the same subject, one in January, relating to the speed of electric currents in submerged wires, and the other in May, to the effect that the speed was not affected by the power of the current employed. In his inaugural address, Sir Charles Bright thus speaks of his experimental researches: "Having a great length of underground gutta percha covered wire under my control as engineer of the Magnetic Company, I carried out a long series of experiments by having the wires connected up backwards and forwards between London and Manchester, so as to form a continuous circuit of a length equal to that of a telegraph cable between Ireland and Newfoundland, or more than 2,000 miles. My method was to use a succession of opposite currents, which I had previously found to be successful with the magneto-electric currents used by that company. I could only try my experiments at night, or on Sundays, when the traffic on the line was small." Mr. Whitehouse, who had been experimenting in the same direction with a cable, was, by means of Mr. Brett, brought into acquaintance with Charles Bright, "the result being that we continued our researches thereafter conjointly until the beginning of the Atlantic line, when we had to divide our labours; he becoming the electrician, and I the engineer of the company." The commencement and formation of the first Atlantic Company will be best told in Sir Charles Bright's own words—the question of the Atlantic having, we must premise, been discussed in 1855 between Mr. Brett, Cyrus Field and himself. "On the 29th of September, 1856, an agreement was entered into between Mr. Brett, Cyrus Field, Mr. Whitehouse, and myself, by which we mutually engaged to exert ourselves, 'with the view and for the purpose of forming a company for establishing and working electric telegraph communication between Newfoundland and Ireland, such company to be called the *Atlantic Telegraph Company*, or by such other name as the parties hereto shall jointly agree upon.'" Mr. Field was, remarks Sir Charles, and he adds: "I am happy to say *is* a man of extraordinary energy and power; rapid in thinking and acting, and endowed with courage and perseverance under difficulties; qualities which are rarely met with." With this opinion we cordially agree; but we think that if Cyrus Field were called upon to describe the subject of our memoir he could not have hit upon more felicitous and happily correct words than those applied to himself. "Professor Morse, the electrician of the Newfoundland Company, had also arrived in London, and Mr. Whitehouse and I showed him one night, October 9th, 1856, at the office of the Magnetic Company in Old Broad Street, that signals could be sent at the rate of 210, 241, and in one experiment at the rate of 270 signals per minute through that continuous circuit of 2,000 miles of the company's underground wires between London and Manchester. The wires were joined backwards and forwards at Manchester and London, in each loop at both ends a galvanometer being inserted in the circuit to prove that the currents really passed through. By this the resistance, though not the *retardation* of the line, was largely increased. On October 20th, 1856, the Atlantic Telegraph Company was registered, Mr. Brett heading the subscription list with £25,000, Mr. Field following him for the same amount. We then held meetings in Liverpool, Manchester, and Glasgow, which were addressed by all of us, the founders, and nearly the whole of the capital, consisting of 250 shares of £1,000 each, was subscribed for in a few days, principally by shareholders in the Magnetic Company."

The details of the Atlantic Cable, its construction and submersion, are matters of history that have been so amply described in many places that we need but gravely allude to the fact of H.M.S. *Agamemnon* being lent by our Government and the U.S. frigate *Niagara* by the United States Government. The manufacture of the cable was equally divided between the firms of Glass, Elliott & Co. and R. S. Newall & Co., both well known as the most experienced cable manufacturers of the day. Ably assisted by experienced colleagues, the two ships were fitted out for the work to be accomplished, with all the necessary appliances, for the great attempt of laying a cable in such deep water. An unsuccessful attempt was made in the year 1857, a failure having taken place soon after paying out from the two ships had commenced. This necessitated a postponement until the following year, when, with renewed hopes, improved machinery, a fresh departure was made, and on August 5th, 1858, the end of the first Atlantic cable was landed at Valentia, and connection with America successfully accomplished. Charles Tilston Bright was immediately after the completion of this great undertaking knighted as a recognition of the great services rendered by him to the country and to science. At the unprecedentedly early age of 26 he received this memorable honour. To those acquainted with submarine telegraphy the enormous amount of energy and resources required for the organisation and fitting out of such an expedition in those early days, may with some difficulty be comprehended, for the details of such an undertaking are simply massive, and reflect credit in the highest degree on the abilities of Sir Charles Bright, who, we may indeed say, on this occasion showed himself "a man of extraordinary energy and power, rapid in thinking and acting, and endowed with courage and perseverance under difficulties"—qualities which enabled him to bring this never to be forgotten undertaking to a successful issue. To the after failure of the cable, and the causes which led to it, we have no occasion to refer here. The result of the exertions of Sir Charles Bright was to prove that Atlantic telegraphy was an accomplished fact, and that communication electrically between the two Continents could be easily and satisfactorily maintained over a distance which science had now proved to be possible.

Of the remaining works of Sir Charles Bright we can only deal in a rapid and cursory manner, for space will not permit our reviewing at length many important incidents of his early and laborious career.

In 1858 Sir Charles assisted Mr. Robert Stevenson, C.E., in advising the Government upon the best type of cable to be adopted for the Rangoon Singapore Cable Expedition. In 1860 he was commissioned by the Spanish Government to lay submarine cables connecting the Balearic Islands with each other, and with Barcelona and St. Antonio on the main land. These cables were manufactured and successfully laid

under his immediate superintendence, a work of some difficulty, as the depth of water in this portion of the Mediterranean was very considerable — 1,400 fathoms.

In 1861 a partnership was formed between himself and Mr. Latimer Clark, who had been for many years engineer of the Electric and International Telegraph Company, a partnership which produced important results. One valuable result we may at once mention, and that was the experiments undertaken with regard to gutta-percha covered wire, to determine the influence temperature had upon its insulation. A very comprehensive and exhaustive series of tests were compiled, which were obtained from a definite length of gutta percha covered wire, specially prepared, and which was subjected to the influence of temperature varying from freezing point to above 75°, and from these a definite reliable result was obtained, and a table of co-efficients worked out, and this remains in constant use at the present time. In the same year a joint paper was read by Sir Charles Bright and Mr. Latimer Clark before the B.A. meeting held at Manchester, on "The formation of standards of measurement of electrical quantities and resistance." This subject attracted so much attention that a special committee was formed, of which Sir Charles was a member. In 1862 the Government of India determined upon uniting the Turkish system of land telegraph at the head of the Persian Gulf, and the Persian land telegraphs at Bushir by means of a submarine cable from those points down the Persian Gulf to Kurrachee.

A cable of great strength and durability was designed by Messrs. Bright and Clark, who were appointed engineers to the work. This cable, its construction and laying, was fully described in a paper read by Sir Charles Bright before the Institution of Civil Engineers in 1865. We may only remark here that the work was of the most important character, and was carried out with that thoroughness which had uniformly distinguished Sir Charles Bright. He proceeded to India himself, and the entire work from beginning to end was carried out under his immediate and personal supervision. In 1865 he received the Telford gold medal from the Council of the Institution of Civil Engineers. Sir Charles Bright was returned to Parliament in the same year as member for Greenwich, and retained his seat until the General Election in 1868, when he declined to stand again. In 1862 he patented (No. 466) an improved method of applying the asphalte composition to the outside of submarine cables—a composition originally patented by Mr. Latimer Clark. This system of protecting the outside of submarine cables was not up to this time largely adopted, as on account of the heat employed, it was found to damage the insulation. The result of Sir Charles Bright's improved method was a plan which has been universally followed, and the composition called "Bright and Clark's compound," became a necessity. The Bright method of applying this hot compound is too well known to need explanation here. We have however the satisfactory assurance of Sir Charles himself that it was a great financial success.

In 1868, being engineer to the Malta and Alexandria Company, he was out in the East, and in the following year we find him engaged in probably that which proved the most arduous of his many laborious cable experiences. This consisted of the large network of submarine cables submerged between the various West Indian Islands, and also the connections with the mainland of South America and Panama; besides erecting the telegraph lines on land and establishing the telegraph stations, upwards of 4,000 miles of cable were laid. This expedition told very severely on Sir Charles Bright, as the continued stay in such a climate had a bad effect upon his health. Many of his staff died, and others were invalided home.

This was the last great work which had the advantage of his personal supervision. The remainder of his life was passed partly in following some commercial pursuits—mining being one of his particular quests—and in various electrical matters. In many things his brother and himself were identified as regards their electrical connections. In 1881 he was appointed by the British Government as one of the Commissioners at the International Exhibition at Paris, and was nominated by the French Government an officer of the Legion of Honour. Sir Charles Bright was a Fellow of several learned societies, and was a member of the Institution of Civil Engineers. He was also from the commencement of its foundation a member of the Society of Telegraph-Engineers and Electricians, and was — as we have already remarked—elected President of that society for the year 1886-1887. His inaugural address will long be remembered for its early recollections and history of the telegraph, and will now be doubtless considered as an "autobiography." His year of office had barely expired before Sir Charles himself had passed to his rest, having acquitted himself of the charge his year of office entailed. He married in 1853 Hannah, daughter of the late Mr. John Taylor of Kingston-upon-Hull, by whom he has issue. His father, Mr. Brailsford Bright, represented the elder branch of an old Yorkshire stock long settled in Hallamshire, a district near Sheffield.

As our contemporary the *Electrical Engineer* said in 1883:—"There are some men whose talents impress us more than any other of their merits, and stand out gaunt and bare like some projecting cliff, with nothing gentle to relieve the eye, or mask the height. There are others in whom a keen intellect is sometimes veiled by geniality of manner, just as a rocky hillside may be overhung with verdure. It is to this category that Sir Charles Bright belongs; and though his past services may well command our admiration, the better part of our praise is that those who have had the pleasure of his acquaintance, love rather to remember the kind and sociable qualities of the man, than the successes of the engineer."

We have endeavoured to give a summary of the life of the late Sir Charles Bright, a life spent from its early beginning with the creation of the electric telegraph, pointing out some of the important works he had been engaged in, some of the improvements he had introduced and originated, and showing at the same time the type and character of the man who could so readily and easily, devise, undertake, and carry out such works. He leaves behind him many of his old friends and fellow-workers to grieve and mourn his loss during the limited time spared to them; but he also leaves behind a monument of lasting fame. The works he has accomplished bear evidence for all time of his skilful handiwork, his intuitive knowledge and unerring judgment, and as the great fabric of the modern telegraph system rises and spreads throughout the world, its foundations and superstructure bear evidence of the vital part played by Sir Charles Bright in their construction and formation, and we may safely assume that so long as the broad Atlantic, separated by its vast expanse of water from this country, carries at its utmost depths the electric connecting chain of communication, so long will the name of the Atlantic and its first cable be connected with that of Charles Tilston Bright.

The funeral took place on Monday, the service being conducted at St. Cuthbert's, Philbeach Gardens (opposite Sir Charles's residence), and the burial in Chiswick churchyard.

Besides a number of relatives, a large and distinguished gathering of friends witnessed the ceremony, amongst those present or represented being:—His Serene Highness Prince Victor Hohenlohe (who, as Count Gleichen, executed a bust of Sir Charles, exhibited in the Royal Academy some years ago), Sir Francis Burdett, Bart. (Sir F. Burdett was a brother mason of Sir Charles's in the Prince of Wales's and Sir Charles Bright lodges); Sir David Salomons, Bart., nephew of the late Sir D. Salomons, who sat with Sir Charles as Liberal member for Greenwich for several years; Sir R. Jardine, Bart., M.P.; Sir F. Goldsmid, K.C.S.I.; Mr. William Lind-

say, Lady Harriet Lindsay and Lady Smart; Mr. Phil Morris, A.R.A., and Mr. Linley Sambourne, of *Punch* fame; Sir W. Thomson, F.R.S., Sir S. Canning, M.Inst.C.E., and Mr. Henry Clifford, the last three his fellow shipmates and pioneers on H.M.S. *Agamemnon* in the first Atlantic cable expedition.

Amongst his professional friends were Mr. Latimer Clark, M.Inst.C.E., for several years his partner; Mr. E. Graves and Mr. W. H. Preece, associated with him from the days of early telegraphy; Prof. D. E. Hughes (as fellow Government Commissioner with Sir Charles at the Paris Exhibition), Mr. F. C. Webb, M.Inst.C.E. (for some time on his staff), Mr. H. C. Forde, M.Inst.C.E., Mr. John Muirhead, M.Inst.C.E., Mr. F. H. Webb, Mr. R. Collett, and Mr. E. Stallibrass, M.Inst.C.E. Amongst those who were out on Sir Charles's last and most trying cable expedition in the West Indies of 1869-1870 were Mr. R. K. Gray, Mr. E. M. Webb, Mr. H. Benest, and Mr. James Stoddart, all of the Silvertown Company.

The Council of the Society of Telegraph-Engineers (of which Sir Charles was last year President for the Telegraph Jubilee), were represented, and also the Royal Astronomical, Geological, and Geographical Societies, and the Institution of Civil Engineers, to which bodies Sir Charles belonged very early in life.

His pupils also were present, and amongst the many wreaths one was placed on the coffin by them; and some of Sir Charles's old mechanics and servants in his different undertakings also attended.

The Burial Service in the churchyard at Chiswick (where the family used to reside, and where the family vault is located), was read by the vicar, the Rev. Lawford Dale, who was a schoolfellow of Sir Charles's at Merchant Taylor's School.

GLASGOW INTERNATIONAL EXHIBITION.

ON Tuesday last, this exhibition was opened with much ceremony by the Prince and Princess of Wales, the day being observed as a general holiday, not only in Glasgow but also in the other large towns adjacent. The weather was splendid, and everything passed off most auspiciously. After six o'clock the exhibition was thrown open to the public, the charge for admission being a shilling, and nearly 36,000 were admitted before closing time. A curious incident of the day was a misfortune which befel the secretary of the exhibition, Mr. W. M. Cunningham, who, while passing along the street, was robbed of his watch and chain, gold badge, and exhibition ticket. The exhibition buildings are rather brightly coloured, but the position, the surroundings, and the general effect are everything that could be desired. Altogether the buildings cover about 14 acres, and the area of ground, with the river Kelvin flowing through it, which has been appointed for the purposes of the exhibition, and enclosed in a green-painted fencing, is about 66 acres, but this again is surrounded by the unappropriated portion of the West-end Park of Glasgow, the higher parts of which command a view of the whole of the building and grounds. The arrangement of the interior of the buildings reminds one somewhat of Manchester, but the sombre terra-cotta hue of that exhibition is lightened and brightened, and the decorations more elaborated. As a display of the productions of the West of Scotland, the exhibits are strikingly extensive and varied, but little value is added to the collection by the contributions from other nations. The machinery department is specially interesting, and, as at Manchester, a gallery round the building affords a convenient means of inspection. The lighting arrangements have been carried out according to the plan which we described some months since, the object of the Lighting Committee being to present examples of the best systems of illumination, and to enable those interested in lighting to compare the efficiencies of the various systems employed, namely, electricity, gas and oil. As to the electric portion of the lighting, the committee entered into contracts with three firms, to each of whom was allotted a distinct section, each section being still further divided into several circuits. The main buildings were entrusted to the Anglo-American Brush Corporation, who have installed 519 arcs, each giving, with a current of 10 ampères, a light of 750 to 800 actual candle-power. The generating plant consists of 23 dynamos, which are driven by engines supplied by Messrs. Robey & Co., Messrs. A. and W. Smith & Co., Messrs. D. Adamson & Co., and Messrs. Greenwood and Batley. The 20 circuits connecting the 519 arc lights represent about 18 miles of 7/16s copper stranded cable. The picture and sculpture galleries are in the hands of Mr. Richard Millar, agent for the Thomson-Houston system. There are 40 arcs burning 10 m/m carbons, and giving, with a current of 10 ampères, a light equal to 800 candles each. The Thomson-Houston dynamos are driven by engines made by Messrs. Robey & Co. The third firm engaged in this work is that of Messrs. King, Brown & Co., who throughout the refreshment and dining rooms have installed 750 incandescent lamps, which are enclosed in ornamental tulip shaped shades, the current being derived from four of their own dynamos, driven by two Westinghouse engines. The fairy fountain is reproduced on the same scale as at Manchester, and with the same equipment and machinery. The largest engine in the lighting department is a coupled compound engine by Messrs. Robey and Co., capable of working up to 350 horse power, fitted with Richardson and Rowland's patent triple expansion gear, for securing economy in fuel and regularity in running. The engine is also so arranged that when driving dynamos for electric lighting the point of cut-off can be automatically varied to suit either varying current or varying E.M.F. By this means the engine can be run either at a constant speed with a compound-wound machine, or at a varying speed to suit the requirements of the current of a shunt-wound machine. When used as a driving engine for factories or mills, it is provided with an arrangement by which the engine can be instantaneously stopped from any floor, if required, in case of accident to life or machinery.

The same firm also supplied the following engines to the exhibition:—(1) A 40 horse-power (nominal) compound "Robey" engine. This engine is erected upon one massive foundation plate, and is capable of working up to 150 horse-power; it is fitted with Richardson's patent automatic governor and cut-off gear. (2) A high-speed horizontal compound engine, developing 20 horse-power, and running up to 400 revolutions per minute, fitted with Richardson's patent electrical regulator for maintaining either constant speed or current. (3) A 6 horse-power (nominal) vertical engine, with inverted cylinder and medium stroke, suitable either for electric lighting or industrial purposes, fitted with patent automatic governor cut-off gear. (4) A horizontal high-speed engine, single cylinder, suitable for 100 lbs. pressure, running at 300 revolutions per minute, and developing 20 horse-power. (5) A vertical high-speed engine, single cylinder, suitable for 100 lbs. pressure, running at 300 revolutions per minute, and developing 20 horse-power. Both of the last-named engines have their working parts entirely enclosed, and running in a bath of oil; they have very large bearing surfaces, and are accurately balanced for running continuously at high speeds without needing lubrication or attention. (6) A double cylinder vertical engine, fitted with reversing gear, suitable for winding or hauling purposes, or general driving. (7) A 10 horse-power (nominal) double cylinder, "Robey" engine and boiler combined, for working up to 30 horse-power. All its working parts are combined upon one base-plate, which also forms a foundation for the boiler. This engine is specially suitable for working in places where great power is required in a very small space, and for export where there is difficulty in getting skilled labour for erection.

In the machinery section are shown a number of systems of electric lighting for steamships. Messrs. Anderson and Munro exhibit a Tower spherical engine with a Goolden dynamo coupled on one shaft; Messrs. Clarke, Chapman and Parsons their patent turbo-electric generator; Messrs. Fielden and Platt their high-speed engine driving a dynamo, illustrating its suitability for ship use; Messrs. Drysdale & Co. the Bon Accord high-speed engine for ship lighting, driving dynamo by belt; Messrs. W. Harvie & Co. a high-speed engine coupled direct to a slow-speed dynamo; Mr. Rankin Kennedy different forms of generating plant for ship lighting; Messrs. King, Brown & Co. combined compound engine and dynamo for use in steamships or where space is limited; and the Anglo-American Brush Corporation a number of dynamos and engines, of compact form, designed for the same purpose. Messrs. Dempster, Moore & Co. exhibit a dynamo driven direct by a 6 inch spherical engine, specially adapted for train lighting. The use of gas engines for driving dynamos is also well represented, including the Otto, the Stockport, the Griffin, the Tangye, the Glasgow, and others. Mr. F. J. Rowan shows his interesting electro-magnetic machines for drilling, rivetting, tapping, and other operations in connection with shipbuilding, engineering, boiler, and bridge work; and Messrs. Greenwood and Batley also have a drilling machine worked by electric current. The "Leeds" dynamo and Armington-Sims engine are employed in lighting the exhibit of this firm.

Sutton-in-Ashfield and the Telephone.—The Local Board at Sutton-in-Ashfield has accepted an offer of the National Telephone Company to establish an "office" in the town upon a guarantee of £20 per annum, and has given permission for the erection of overhead wires.

INCANDESCENT LAMP PATENTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* HOLLAND AND OTHERS.

(*Before* Mr. JUSTICE KAY.)

(*Continued from page* 486.)

THURSDAY, MAY 3RD.

Dr. CHAS. MEYMOTT TIDY, examined by Mr. FINLAY, Q.C., said: I have endeavoured to make filaments in all the ways described in Edison's specification, with the exception of the coiling round copper. I regarded the materials to be used as coming under two heads—under the first class, wood paper and cotton thread; the second, what I think is called Edison tar putty. As regards the first class, I attempted to carbonise about 50 filaments in as small a crucible as possible, without packing, the top of the crucible being fastened on with Stourbridge clay, and the whole of them disappeared, with the exception of a little ash. I then tried the ordinary method of packing with powdered carbon, and succeeded. Thirdly, I used sand, as suggested by Sir Frederick Bramwell, and again the filaments were burnt up. An ordinarily intelligent workman would most certainly not have understood in 1879 that packing with powdered carbon was necessary. The process of carbonisation then known to me was that for carbonising wood for gunpowder manufacture. Skill in that process of carbonisation would not enable a workman to successfully carbonise filaments for incandescent lamps, because in that case a certain loss was of no consequence, whilst in carbonising fine filaments it would be fatal. I was particularly struck in 1881 or 1882 when I first saw the process of carbonising filaments as shown to me by Mr. Crookes. I tried making tar putty filaments, and found difficulty in obtaining the material of the proper consistency. I adopted Edison's process precisely, igniting the lampblack first, and mixing the ignited lampblack with the tar. Edison gives no directions as to proportion. If you use too little tar the thing comes to pieces with the greatest ease long before you get what may be called a fine wire; if you use too much tar the thing runs so that you can do nothing with it. After a great many trials I got a wire of the material—I should say about $\frac{1}{15}$th of an inch in diameter—quite as small as I could get it, and that was obtained by rolling it on a glass plate, dusting the glass plate with a little of the powdered charcoal, and rolling it with a spatula. I tried to make a spiral of it, but failed. I have seen that Mr. Crookes did get a spiral, but I do not profess to possess his extraordinary manipulative ability, and I failed. I carbonised the specimen, packing with powdered charcoal, and when I opened the crucible the whole thing came to nothing. Moulds are certainly necessary to prevent distortion of the filament during carbonisation. I did not myself know of the use of such an apparatus until many years afterwards—until about three months ago, in fact. I used no moulds, for I was following Edison. The filaments I produced I could scarcely imagine used in a lamp. I joined the platinum and the filament before carbonisation. By carbonising the two in conjunction the platinum was rendered more porous and a carbide formed. This would render the filament of little use, I should think, for the purposes of a lamp. I saw several of Mr. Crookes's experiments, and agree with what he has said regarding them absolutely. I have myself tried camphor and oxide of zinc in making filaments, and found that it rendered the tar putty substance even more difficult to manage, more difficult to work with before carbonisation, and more friable afterwards. I never got a filament a quarter of an inch long after carbonisation when using those substances. That I attribute to the reducing power of the oxide of zinc on the carbon, and to the volatility of the metal. If the oxide of zinc was not reduced in the carbonising process it was certain to be reduced in the lamp. I have never known on the market a lamp made according to Edison's specification. Assuming Swan's lamp which I have seen to have been made previous to November, 1879, I say that it combines all four details contained in Edison's second claim. I have seen the list of non-conducting, non-carbonisable substances put in by Prof. Crookes, and, whilst it is not complete, it is a very good list of substances which would be suggested by the statement in Edison's specifications.

Cross-examined by Mr. ASTON, Q.C.: My knowledge of the subject of electric lighting of incandescent lamps commenced about 1882. My knowledge of carbonising prior to that time was confined to gunpowder manufacture. I do not think it at all probable that a workman used to carbonising electrodes for arc lamps would know about packing with powdered charcoal. Possibly differences of temperature might have rendered the tar putty filaments which I produced less brittle and friable; the time for which they were subjected to heat might also make a difference.

Prof. SILVANUS P. THOMPSON, examined by Mr. FINLAY, said: I first met Mr. Stearn in the year 1877 at the meeting of the British Association at Plymouth. Mr. Stearn there exhibited the improved Sprengel pump. In 1880 I visited Mr. Stearn's house at Rock Ferry, and there saw incandescent lamps, with which the house was illuminated, and which were made entirely of glass, through which the leading wires passed, containing a thin conductor consisting of a carbon wire, and which had been exhausted. I was at the British Association meeting at York in 1881. A picture gallery in which one of the conversaziones was held was lighted by Swan lamps of the same kind generally as those I had seen in Mr. Stearn's house. I went to the Paris Exhibition in the same year, and there again saw a large number of Swan lamps of the same kind; whether the wires were thicker or thinner I can't say. I there first saw Edison lamps. I examined the lamps shown publicly as closely as I could without taking them into my own hands, and afterwards had the opportunity of examining personally lamps of the same type; they were lamps which would come under Edison's second claim, but contained many improvements in detail upon the lamp described in Edison's specification. They differed from that description in some nine respects: (1) the carbon conductor is made in accordance with Edison's later specification, No. 578, 1880, the paragraph beginning page 3, line 31; (2) so far as I can judge has been held in shape during carbonisation in the manner claimed in a subsequent specification, No. 3,765 of 1880; (3) the carbon conductor has its ends left large in the manner described in specification No. 1,918 of 1881; (4) the clamp which holds the end of the carbon conductor is flattened in the manner described in specification 2,492 of 1881, page 11, line 15 and fig. 6; (5) the joint so made has been electroplated in the manner described in specification 768 of 1881, page 4, line 10; (6) between the end of the carbon conductor and the platinum wire, which is fused to the glass, there has been joined in a separate piece of wire, not of platinum, in the manner described in specification 4,174 of 1881, page 6, line 10, and fig. 7; (7) the bulb has not been blown over the rest of the lamp as described in Edison's specification, but has been separately made in accordance with specification 2,492 of 1881; (8) the platinum wires that pass through the glass are connected to the terminals of another metal in the manner described in the specification 2,492 of 1881, p. 12, line 5; (9) the lamp has been provided at its neck with collar connections in the manner described in specification 1,802, of 1881, page 6, line 27, and page 14, line 33, and shown in fig. 1. A tenth point is to some extent a matter of opinion, that this lamp has been heated during the process of exhaustion in the manner described in specification 562, of 1881, p. 11, line 40. The Edison lamps compared very indifferently indeed with those of Swan's which were exhibited. The idea which struck me when I entered the room where the Edison exhibits were was that the light was very red, and that it was a miserable exhibition compared with Swan's. The Edison lamps were larger in themselves than those I had seen at Mr. Stearn's, but they were run at lower power and did not give so good a light. Mr. Stearn's lamps were very effective. In November, 1879, electricians were aware of the advantages of high resistance, which are entirely external to the lamp itself, enabling you, in cases where you wish to distribute electric energy to a distance, whether for lighting or for motive power, to economise the cost of the conducting mains. It was undoubtedly known in November, 1879, that to obtain high resistance you would diminish the sectional area and increase the length of the conductor, or employ a material of higher specific resistance. I have here some specimens of Carré carbon of 1 mm. diameter, which were given me by M. Carré at Paris during the Exhibition of 1878. I have never seen Carré carbons manufactured, but have read the description in Fontaine's book. At the date when I obtained these carbons there was nothing better known for the purposes of electric lamps. For an individual lamp attenuation of the carbon undoubtedly diminishes the life of the lamp, and does not increase its efficiency. Taking Mr. Swan's lamp with the stick conductor the size of the wire has no disadvantage. The glass, assuming that the proper kind of glass was employed, would not crack as the result of wires of that size being fused into it. There is no greater waste of energy in that Swan lamp than in lamps with smaller conductors. For lighting in series at about 16 C.P. low resistance lamps are preferable; indeed, low resistance lamps in that case must necessarily be used; for lighting in multiple arc high resistance lamps are used. The difference between the exhibit (Swan stick-conductor lamp) and the Swan lamps I saw in Paris is mainly a difference of form and size; the Paris lamps had conductors made of a longer and thinner wire of carbon, and the conductor was looped round so that its two ends were close together, the leading wires passing out at the same end. In specification 792, of 1881. Edison points out the commercial usefulness of low resistance lamps. I saw the two safety lamps which Mr. Swan exhibited at the British Association meeting at Birmingham. The lamps were of exactly the same shape as the exhibit; they burnt perfectly well. I do not consider that a workman of ordinary intelligence and skill could have made a useful incandescent lamp from this specification alone, because in the first place the general tenour of the specification would mislead him as to the character of lamp which would be serviceable, and, secondly, there are no instructions as to the processes of manufacture such as a practical workman would require. I have never known a lamp made under this specification on the market. I do not think there is anything in the specification which indicates precisely what was meant by a filament. I have always looked upon it as a sort of general term applied to all the materials spoken of, strips, sheets, threads, and so on.

MONDAY, MAY 7TH.

Prof. SILVANUS THOMPSON, continuing his evidence, said: I was about to add when the Court rose that I could see no difference between the exhibits J. H. 2 and J. H. 3, and that the joints in both appeared to be made in a manner quite different from anything contemplated in Edison's specification. They appeared to me to be made by the deposition of carbon. Looking at the series of lamps made by Mr. Gimingham, and produced by Mr. Imray, the first has a conductor made in a spiral of three turns, and the

coils of the spiral are so open that they could not fulfil the requirement of offering only a small radiating surface. There is no appearance on the platinum wires indicating that they have been subjected to the process of carbonisation; the platinum wires attached to the carbon are not mounted to other platinum wires by means of little screw clamps, and they are supported just below the joint by a little piece of the disc of glass in the manner described in specification 539 of 1881; the wires themselves are sealed through the glass after the manner described in specification 4,174 of 1881; the conductor in this case, as nearly as I can measure from the outside, is $\frac{20}{1000}$ths of an inch thick, or No. 22 or 23 B.W.G.; there is considerable discolouration on the lower part of the bulb, due, I should suppose, to incomplete driving off of the tar in the cement at the joint or in the conductor itself. The second lamp has an uncoiled conductor, the platinum wires show no appearance of carbonisation, discolouration is less marked and is browner, there are no internal clamps, and the conductor appears to be No. 27 B.W.G., between $\frac{16}{1000}$ths and $\frac{17}{1000}$ths of an inch thick. The next lamp has a conductor of carbonised cardboard in the form of a horseshoe; it appears to be quite rigid, does not visibly vibrate when the bulb is tapped; the dimensions of the conductor appear to be $\frac{18.1}{1000}$ths of an inch broad, and $\frac{17}{1000}$ths of an inch thick, having therefore a section equivalent to a pencil $\frac{40}{1000}$ths of an inch diameter, or No. 18 B.W.G.; the bulb, so far as I can judge, appears to be a machine-made bulb, separately made and put on afterwards, not blown over the rest of the lamp, substantially in accordance with specification 578 of 1880. The fourth lamp has great discoloration of a yellow tint, due to the same cause, incomplete evaporation of the tar; the conductor is rigid, exhibiting no visible vibration; it is arched instead of being coiled; the bulb appears to be a machine bulb; and from the appearance of the conductor, I should judge that it has been held in shape during carbonisation in the manner described in specification 3,765 of 1880; there are no clamps internally, and the platinum wires show no trace of having been carbonised. The fifth lamp of the series has no clamps, the wires show no traces of carbonisation, the bulb appears to be machine blown, the conductor, apparently of thread, is not coiled, and the discoloration in this case is very small. Of the lamps produced by Mr. Gimingham, and made by himself professedly in accordance with Edison's specification, the first has a conductor looped, not coiled, there are no internal clamps, the bulb appears to be separately blown, and there is a yellow discoloration. The second has a coil of three turns wide apart from one another, there is an internal support of glass just below the mounting, the wires, which are sealed direct through the lower end of the bulb, show no evidence of carbonisation, and the conductor is $\frac{23}{1000}$ths of an inch thick, or No. 24 B.W.G.; there is a peculiar globular appearance on the conductor, by no means common. The third has a conductor which does not visibly vibrate when tapped, the bulb appears to have been separately joined on, and the wires have no appearance of carbonisation. The conductor appears to have a conductor of No. 27 B.W.G., or $\frac{16}{1000}$ths of an inch thick. The fourth has a spiral of five turns, wide apart, and the bulb appears to be machine made, and there is a slight discoloration. The fifth, a looped filament, of lampblack and tar, No. 25 B.W.G., or $\frac{20}{1000}$ths of an inch thick. The sixth has a coiled conductor broken off, there is a glass support, and the wires pass out direct through the bulb. In the seventh there are the same differences from the description of the specification, and the carbon conductor appears to be very fluffy. These I should hardly think would be good commercial lamps; I doubt if they would be durable. With regard to the two specimens produced by Prof. Crookes, with conductors coated with non-conducting, non-carbonisable substance, the first is a lamp which was made at Mr. Crookes's and tested in my presence, while still on the pump, and I saw the reaction taking place which ended in the destruction of the lamp; the other I did not see tested. With regard to the further exhibit of Prof. Crookes, said to be Edison's bamboo lamp, I think I have already said I don't think it is bamboo at all. Whatever it is it has been subjected to some subsequent process; the surface is covered with something, and is quite shiny and metallic. It differs from every lamp I have ever seen put into the market as an Edison bamboo lamp in several ways; the jointing is done in a different way, the platinum wires are in one piece, and, in fact, it has not the peculiarities of the lamp I spoke of as being so largely used in 1882. I never saw a lamp like this before this trial. I have examined the filaments of tar putty put in in cross-examination of Prof. Crookes by the Attorney-General; *a*, *b* and *c* are about $\frac{40}{1000}$ths or $\frac{41}{1000}$ths of an inch thick, not quite uniform, though very nearly, but they exhibit a number of small cracks; *d* is about half as thick and is not so uniform, being much thinner in some parts than others; *l* is a spiral a good deal thicker than any of the others, has been carbonised, and presents inequalities. I have myself tried to make tar putty filaments, which I produce. I made them last Wednesday, that being the third occasion upon which I have tried. Four years ago I tried rolling them on a slate, and gave it up as hopeless; the second occasion was at Prof. Crookes's, using part of the same mixture which he used, and the best results I obtained there were not so good as those I obtained on Wednesday, when I used some of the ordinary laboratory sample of lampblack. The tar was previously ignited for three hours. I tried rolling them on a slate and on the palm of my hand, on a porcelain plate, on a plate of glass, on paper, and, last of all, on a rather coarse piece of cardboard, and the best results were got by rolling the stuff on a clean piece of cardboard, using another clean piece of cardboard to roll them out. Rolling on glass was an entire failure, so also was rolling them on the porcelain plate. After rolling several on cardboard the cardboard got so sticky that I could roll no more, and had to get a fresh piece. Those I completed when put aside contracted and broke, some into two or three pieces. I tried rolling the thread in the tar putty, but could get nothing thinner than about $\frac{30}{1000}$ths of an inch. I tried coiling them, but they were very unmanageable, as they were so extremely brittle. I tried coating the same with a non-conducting, non-carbonisable material, the most convenient at hand being powdered chalk. That substance gave an impracticable result; it could not be rolled to any length. I tried mixing the tar putty with camphor. Upon adding a little camphor to the putty already prepared it grew more plastic, having the same physical effect as adding more tar. I therefore had to add more lampblack to bring it back to the stiff putty consistency. Upon rolling this out the camphor evaporated so fast that the substance crumbled up, and I could not get a piece 1½ inch long thinner than about $\frac{45}{1000}$ths of an inch. I tried adding zinc oxide to the tar putty, and it acted in the other way; instead of making the material more plastic it made it more crumbly; but correcting this by adding more tar, I obtained a material easier to roll out than any other combination that I had tried. I consider the tar putty process, as a whole, quite an impracticable one for commercial use, on account of the contraction which goes on, and the liability to distortion and fracture; and the addition of camphor is fatal to the working of the process. Every one of these specimens I have here was complete when I laid it down on the sheet of paper, and all but two broke while the paper was resting upon a rigid table. I was present when Prof. Crookes was endeavouring to coat some of these tar putty filaments with fire clay, and also saw the results of running the lamps the conductors of which had been coated with some other material. I have heard the evidence given on the point, and entirely agree with it. I have to add that these lamps I saw tried were sealed to the pumps while they were being tried, and they were heated while the current was passing through them, first gently, then more strongly, and I saw no depression in the pump indicating that the gases were being given off until the conductors had been raised to full yellow heat; and before the conductors had been raised to whiteness, with the ordinary running of the lamps, before any arc had been formed at any part of the conductor, gases began to be given off, producing a depression of 12 inches in the mercury, and at the same time the bulb was more or less filled with a faint glow, and portions of the conductor became of themselves more highly luminous. It was at this stage that the spectroscope showed lines indicating the volatilisation, and, of course, the reduction of the materials in the non-carbonisable coating. I know of no non-conducting non-carbonisable substances which would not behave in the same way as did those I saw treated. I have examined the Cheesbrough specification, and I witnessed Prof. Crookes's experiment relating to that process, and agree with what he said. I am familiar with the papers of Despretz and Sidot, and regard the substance given by Cheesbrough's process as absolutely identical with that produced by Despretz in one of his experiments; the processes themselves appear to me to be merely variations in detail of the same process, namely, heating by an electrical current which becomes incandescent, acts upon the surrounding fluid containing carbon, and dissociates carbon from it, becoming coated thereby. The term hydro-carbon has a perfectly definite meaning to me, a substance containing hydrogen and carbon and nothing else. In that sense Cheesbrough has struck out in his complete specification the only two hydro-carbons mentioned in his provisional, naphtha and turpentine. The material yielded by Sidot's process is the same as that yielded by Despretz and Cheesbrough; the process differs only in the method of applying the heat. The physical action is the same, that is, the decomposition of the surrounding fluid resulting from contact with a highly incandescent substance.

Cross-examined by Mr. FLETCHER MOULTON, Q.C.: Do you say that Cheesbrough's conductors could be obtained by Despretz's process?—Yes, I certainly think so.

Can they be obtained as conductors with the same regularity as by the Cheesbrough process?—The carbon would be deposited in perfectly regular layers wherever the incandescent substance was in contact with the gas.

That is not quite an answer to my question. I ask you whether you can obtain these conductors with the same regularity in them as by Cheesbrough?—As far as regards regularity in the material, I think the two processes produce the same uniformity. With regard to regularity of form I don't think that Sidot's process, without modifications, would produce as great a uniformity of form as Cheesbrough's.

For the purposes of acting as electrical conductors in an incandescent lamp the substance and form are both important, are they not?—Not necessarily. In a good modern lamp the process of flashing does not produce a uniform conductor.

Then what is of importance is uniformity of electrical resistance?—Not even that.

Will you kindly tell his lordship what is of importance?—It is of importance that the conductor should be so built up or shaped that it should glow at every point of its surface with an equal degree of incandescence.

Do you suggest that you could get that by Sidot?—By modifications, no doubt.

Do you suggest that you could get that by Sidot?—Not by the Sidot process alone.

Is it not a fact that you can get that by Cheesbrough and by no other process?—I do not think that is so.

Can you get it by Cheesbrough?—By applying portions of

Cheesbrough's process, but Cheesbrough does not tell you how to do it.

But by the process Cheesbrough describes it can be done?—Oh, yes.

I put it to you that it can be done by that and by no other known process?—Oh, no. It can be done in the manner described in specification 562 of 1881, page 8, line 17, which describes a method of applying heat from an external source.

Have you ever tried that?—No, nor Cheesbrough's process.

Do you think that would in practice produce the same result?—It would deposit carbon, certainly.

Have you ever heard of a single lamp being made in this way? No; the process of flashing by applying external heat has never been employed.

This method would not act automatically, would it?—I think not.

Is there anything automatic in the correction?—Yes, I think so. When heat is applied it does not matter where it comes from, carbon is deposited at the points of greatest heat.

In 1879 was it not perfectly well known that in order to prevent the oxygen attacking the carbon during carbonisation you must have, if there be sufficient oxygen present, something to take it up?—I do not think it was known.

Was it not well known that to prevent your carbon being attacked by the air, if any, left in the crucible, you should put in powdered charcoal?—In the first place I had never heard of carbonising in a crucible; in the second place, my notion of carbonisation at that date was that it consisted of imperfect combustion, that notion being solely derived from the process of carbonising wood charcoal. As a matter of fact, when I first read this specification I remember pausing at the words "properly carbonising," and wondering what was meant.

Then the word "properly" sounded in your ears like a note of warning?—Yes, to look for the process.

Did you obey the warning voice and look out for the process?—Oh, yes.

Where?—Throughout that specification.

Did it not occur to you to look around to see whether in the knowledge of the world at that time there was such a thing as a knowledge of proper carbonisation?—I do not think I did look it up. I depended upon the mode of charcoal carbonising.

In "Chambers's Encyclopædia," dated 1861, under the article "Carbon," there is reference to the carbons used in Bünsen batteries. Do you know how they were made?—I knew the process in general.

That was carbonising, was it not?—Oh, no; you took carbon to begin with, and wound it up and mixed it with some kind of material, generally sugar, pressed into moulds and heated in a furnace.

Was it not put into a closed chamber?—No.

Is not a mould a closed chamber?—In one sense it is, in another it is not.

"Chambers's Encyclopædia" speaks of packing with charcoal dust in a fire-proof chamber. Having read that, do you tell his lordship that it was not well known that in carbonising, where you did not want to destroy the thing, you might use charcoal dust?—It was not known to me.

Do you mean to say——

Mr. JUSTICE KAY: Prof. Thompson says it was not known to him, and the inference is that it would not be known to the skilled workman. I quite understand his answer.

Mr. MOULTON: You knew that it was necessary that air should be excluded?—To some extent, yes.

You knew the importance of this would be increased by the small size of the object?—If I had thought of it I dare say I should have come to that conclusion.

You said J.I. 3 was a machine-made bulb. What are we to understand by that?—My impression was that it was a machine-made bulb.

What has that to do with it——

Mr. JUSTICE KAY: It was not blown over the lamp, as Edison describes. That is all he says.

Mr. MOULTON: What is the passage you refer to about it being blown over?—Page 4, line 48: " . . and a glass bulb blown over the whole with a leading tube for exhaustion by a mercury pump.

I do not know whether you suggest that it makes any difference whatever whether it is blown before or after; whether it is ready-made blown, or blown over?—It would be difficult to blow a bulb over the delicate arrangement you have in a lamp. I should not have mentioned this had not Edison himself taken out a patent later for blowing bulbs.

Mr. JUSTICE KAY: Prof. Thompson has been asked to point out wherein these lamps differed from Edison's specification, and he has done so.

Mr. MOULTON: Do you suggest that anybody would have the least difficulty in understanding what Mr. Edison meant?—I think not. I think it is quite clear what he meant.

What do you think he meant?

Mr. JUSTICE KAY: He meant blowing the bulb over the filament.

Professor JOHN PERRY, F.R.S., examined by Mr. GRAHAM: I remember a meeting of the Society of Telegraph Engineers and Electricians in November, 1880, at which some Swan incandescent lamps were exhibited; they were very much like the lamps in use at the present day. Upon that occasion Mr. Swan delivered a lecture upon the subject of the lamps. During the British Association meeting in August, 1881, Swan lamps lighted up the Picture Gallery at York. Before that time, in May, I had measured the efficiency of the Swan lamp. I believe Professor Ayrton and myself were the first to measure the efficiency of these or any lamps. The efficiency of the Swan lamps in 1881 was exceedingly good, compared with lamps of the present day. In October, 1881, I measured the efficiency of the Swan and Maxim lamps at the Finsbury Technical College. At that time we obtained a very much higher efficiency than is ever obtained now from incandescent lamps in regular working, because at that time it was not sufficiently well-known that lamps may be made to give out too much light for their life. With regard to the lamps exhibited by Mr. Swan at the Society of Telegraph Engineers, I am in a position to say, from their bright appearance, that they must have been burning at much the same efficiency as lamps of the present day. They burned there for several hours, and must have undergone a considerable amount of testing before he dare venture to exhibit them on such an occasion. The Savoy Theatre, in 1881, was lighted with over 1,000 Swan lamps. I first saw an Edison lamp at the Paris Exhibition about the end of September, 1881. Upon the same occasion I saw a great number of Swan lamps burning. The Swan lamp had the appearance which lamps now have; the Edison lamps had a reddish orange appearance, and from my knowledge of electric lighting I know that they must have been burning very inefficiently. In 1874 I explained the construction of a magneto machine, with a Gramme armature, to many electricians at the British Association meeting; electricians in this country, before that time, were almost entirely ignorant of its construction. In 1878 the Gaiety Theatre was lighted by means of arc lamps. To use such machines as were known in 1879 with filament lamps would certainly result in the destruction of the lamps, because the dynamos of that time were very likely to alter the electric pressure by a few volts; many means have been taken since that time to maintain the pressure almost absolutely constant. If a lamp of 100 volts is run at 101 volts its life is only about three-quarters as long as if run at its proper pressure; sudden changes of 3 or 4 volts would destroy it. Mr. Brush took out a patent for compound winding the field magnets of dynamos. The effect of compound winding, which, however, was not properly developed until some time after 1878, was that if a dynamo was driving 100 lights, and most of these lights were suddenly put out of circuit, the remaining lamps would be worked at the same pressure as before. I have heard Professor Thompson's evidence with regard to the advantages of high resistance, and I agree with him. I have seen Mr. Swan's lamps put in by Sir Frederick Bramwell. Having regard to the sort of dynamos in existence in 1879, I believe it would be of very nearly the minimum thickness for incandescence by the dynamos of that time, taking into account that running with the pumps was unknown. I think it was very much better able to resist the shocks than anything which could have been made under Edison's patent. The globe of that lamp is slightly blackened; and I have no reason for believing that this is caused by anything else than by being run at too high pressure. This has something of the appearance of Mr. Maxim's lamp after it broke down, and I obtained some extraordinary high efficiency results with that lamp. In the Edison lamp the carbon comes into contact with the platinum inside the lamp. It is exceedingly unlikely that any chemical action would take place at the joint. There is a comparatively large mass of metal at that joint, so that the carbon is there a great deal cooler, and besides the platinum wire conducts the heat away from that part rapidly. I observe that the lamp E.G. 3 (put in by Mr. Gimingham) is slightly dulled. I understood that it gave a measurement of 16 C.P. When a lamp is measured for only a short time giving 16 C.P., and is dulled in colour in this way, it is evident that its life would be short. I should say this lamp had an efficiency something like that of a modern lamp, 5 watts per candle, but the lamp put in later (E.G. 7 or 8) uses 15 watts per candle, and must have been working, when its measurement was taken, at much below the ordinary whiteness of incandescent lamps, so that in my opinion it could not have been white hot.

Mr. FINLAY: Going to Cheesbrough, and reading that part of his specification which says that as the carbon increases in size more current is required to maintain its temperature, what have you to say about that?—He was probably using a battery like Despretz, and in that case the current would automatically increase and maintain the temperature.

Assuming that you used a dynamo machine in carrying out that process, what would happen?—The temperature would certainly increase faster. It would be necessary to adopt some means for increasing the resistance rather than diminishing it.

Have you to make any special provision for increasing the current when you use the dynamo?—No.

You have heard it stated that Despretz used an enormous current when he made his experiments. Have you any remark to make about the current he used?—The total output from those 600 cells which formed the largest battery used by Despretz, was probably considerably less than ½ H.P., and that is an exceedingly small amount of electrical energy.

Dynamos of 100 H.P. are quite common?—When I was last at the Crompton works I saw several of 100 H.P., and was told that some of 500 H.P. had been sent away. I do not know for what purpose the 500 H.P. machines were destined, but those of 100 H.P. were certainly for incandescent lighting.

Cross-examined by the ATTORNEY-GENERAL: Were not the novelties of the Swan lamps which you saw in 1881 that they consisted of a vessel of glass, platinum leading wires, a filament of carbon, and a perfect vacuum?—Certainly not. He used the same combination in 1878.

Will you kindly tell his lordship what you say was the novelty of the Swan lamp in 1881?—That he had manufactured an exceedingly large number and had made a commercial success of them.

Describing them as incandescent lamps would you not have said that the Swan lamps consisted of vessels of glass with leading wires sealed in them, carbon filaments, the vessels of glass being exhausted?—I might have said something like that.

Does that lamp (handing new exhibit to witness) represent a Swan lamp of to-day?—Yes.

Speaking of its leading features, does not that consist of a vessel of glass, leading wires sealed in it, a carbon filament; the vessel being exhausted?—Yes; I think so.

There has been a large number of patents for improving these lamps?—A large number.

Improving the carbons has been one line of patents, has it not?—Yes.

Improving the mode of attachment between the platinum wire and the carbon another?—About all the details there have been a great many patents.

Is it not a fact that the only diploma of honour for electric lighting given at the Paris Exhibition was given to Mr. Edison?—I do not believe that is a fact. I think he had a diploma of honour for his exhibit, which contained many other things.

Beyond the general features of these lamps, the glass globe, leading wires, carbon filaments, vacuum, is not everything else a matter of detail?—Yes; but there are some very important details.

You said when I suggested that these features were novel in Swan's lamp of 1881 that he had the same thing in 1878. When did you first see F. J. B. 1, or one like it?—Close to me, just now. Similar lamps I first saw, at a distance, perhaps two or three years ago.

When did you first see a commercial incandescent lamp at all?—I am not quite sure, but I think at the exhibition which Mr. Swan made at the Society of Telegraph-Engineers on November 24th, 1880. I do not distinctly remember seeing a lamp before that.

Excluding this F. J. B. 1, can you point to any publication before November 10th, 1879, which contained those four leading features as being the features of a useful incandescent lamp?—I do not think I can find it.

Are you aware that Mr. Swan patented his lamp—the very thing you have been referring to—in January, 1880?—I will take it from you that that is his first patent.

Mr. Swan, you think, did find out a good deal about these lamps?—Yes; to Mr. Swan and Mr. Lane-Fox together the credit is due.

There are not many Lane-Fox lamps alight now are there?—What do you mean by Lane-Fox lamps?

Any lamp which is made in accordance with any patent of Lane-Fox's.—Most lamps one sees have some of Lane-Fox's points.

You know Prof. S. P. Thompson, and that he has written to explain these things to people? I am now reading from his book. Is it not a fact that immediately after the beginning of 1880, Swan, Maxim, Lane-Fox, Crookes and Akester brought out carbon lamps?—Swan, Lane-Fox, and Maxim did. I do not know when the others were brought out.

Mr. Swan used a parchmentised cotton thread in 1880?—I presume so.

Maxim used paper?—I believe so.

Lane-Fox used broom fibre?—I believe that was one of the materials he used.

Crookes used vegetable fibre parchmentised by chloride?—If it is in that book it is probably correct.

The despised man Edison used flat strips of carbonised bamboo?—Yes.

Are not paper, cotton thread, vegetable fibre, all to be found mentioned in Edison's specification?—Yes.

Had you ever seen an electrical incandescent lamp at all before the beginning of the year 1880?—Oh, certainly; not of carbon, but platinum.

Where had you seen a platinum lamp?—I had made them myself.

In a vacuum?—No.

Then, what you call an incandescent platinum lamp is making a piece of platinum red or white hot in the atmosphere?—Yes.

Was that a commercial lamp?—No.

Would you call that an electric lamp at all?—If I used it for lighting I would. Mr. Edison created all the sensation in 1878, when gas shares fell so, by means of an incandescent platinum wire.

You have described the extraordinary difference between dynamos and batteries. What inference do you draw?—I have already given any inference I draw.

Well, I have missed it. What bearing has it upon these lamps?—I must ask for a more specific question than that.

Very well. Were the Swan lamps at Paris in 1881 worked by a dynamo?—I believe so.

And has not every practical installation been ever since the year 1880 run by dynamos?—Through accumulators.

Secondary batteries being used for storage?—No; secondary batteries being used to regulate the current, and do what a bad dynamo in 1879 would not have done.

Have not many installations been run without batteries at all?—Since 1882, perhaps.

Were there any permanent installations lit at the Paris Exhibition by secondary batteries?—There was a tremendous show there of Faure accumulators, and I think, although I am not quite sure, that many lamps were run from them.

Was the alternating current machine known at that time?—I believe the Swan lamps were run from an alternating current machine.

You would not use secondary batteries to regulate them?—No.

The Savoy Theatre installation was run direct from a dynamo, was it not?—Yes; but an immense improvement took place in dynamos in two years just then.

You have spoken of running lamps too high. You said an increase of 1 volt in 100 volts would shorten the life of a lamp by one quarter?—Yes; about 78½ per cent. really.

Five or six volts increase of pressure would cut it down much more?—Very much more.

The ATTORNEY-GENERAL intimated that he would like to stop here for the day.

Sir HORACE DAVEY made an application to the court upon a written statement, which he said could be verified by affidavit, for permission to take the evidence of M. Carré in Paris.

The ATTORNEY-GENERAL said that at this stage of the case such an application should be supported by evidence that M. Carré could not attend personally, and

Sir HORACE DAVEY said he would repeat his application next morning, when he would have affidavits ready.

The Court then adjourned.

TUESDAY, MAY 8.

Sir HORACE DAVEY renewed his application with regard to taking M. Carré's evidence in Paris; but

The ATTORNEY-GENERAL said that, in view of the expense that would be incurred by that course, it would be much better to avoid it if possible. If Sir Horace would state what M. Carré was to prove, he might be able to admit the facts.

Eventually it was agreed that it should be taken as admitted that F.J.B. 1 (Swan's stick lamp) contained carbon made by Carré, and that Swan got it from Carré; the Attorney-General would consider whether or not he could admit that the carbon was carbonised after receiving its present shape.

The ATTORNEY-GENERAL continued his cross-examination of Prof. Perry: Have you ever yourself carried out Despretz's process?—No; nor Cheesbrough's.

Where do you say the process was stopped short of rupture or volatilisation?—I gather from certain experiments that in the cases to which they refer the carbon was not fused or broken.

Speaking generally, is there not in the electrical arc a drop of about 30 volts pressure between the positive and the negative pole?—I have never calculated that.

If you put a piece of lime of the same size as the piece of carbon between the poles of the arc, would there not be the same deposit upon the lime as there would be on the piece of carbon?—I cannot say.

Have you for yourself tested for the internal, automatic, remedial action in the Cheesbrough process?—No.

If a lamp is run at too high a pressure, the effect would be to shorten its life, and the inside of the globe would be blackened?—Yes.

Every lamp has a pressure beyond which it ought not to be run?—Yes, for its usual life, say 1,000 hours.

What reason have you for saying that Mr. Gimingham did not run his lamps at proper illuminating power when he gave the life of the lamp?—I think he said he used 75 volts and 1·2 ampères; that means 90 watts. He obtained 6 C.P. from that lamp; that means 15 watts per candle. That is enough to enable an experienced electrician who has measured lamps before to say that the lamp could not have been white hot as described.

What watt-power would have made it white hot?—In the latest lamps I believe about 3½ watts are used.

Has not the whole science of electrical measurement been built up within the last five or six years?—Most certainly not.

Then when did it begin?—With the first experiments on the radiation of heat.

As a matter of fact, was not the first publication upon the subject of electrical measurement in the TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW of May, 1880, by Henry Morton, Alfred Mayer, and Prof. Thomas?—Do you mean in the sense of watts per candle-power?

I am not speaking about watts per candle-power. Was not that the first publication on the subject?—No; I don't think it was.

Will you produce an earlier publication?—If I hunted for it I have no doubt I could.

Will you produce at any time an earlier publication regarding the electrical measurement of lamps than May, 1880?—I am not quite sure; I could if I had time.

You shall have time; any time during this trial you may produce it?—I am quite sure I shall be able to produce such a publication.

Mr. JAMES SWINBURNE, to the examination of Sir HORACE DAVEY, Q.C., said: I have had a great deal of practical experience in electric inandescent lamp manufacture. The first Edison lamp I remember seeing was in the Paris Exhibition buildings, the day after the exhibition proper was closed. That lamp was not made in accordance with Edison's specification. In my opinion it certainly could not have been made by reference only to that specification. I quite agree with Dr. Frankland's and Prof. Thompson's evidence upon that subject. I was first employed as a maker of incandescent lamps at the Swan Works at Gateshead, where I remained a month or five weeks; afterwards I went to manage the Paris Works of the Swan Company, remaining there for six

months, afterwards going to the United States to organise or start very large incandescent lamp works. After that I was manager of the incandescent department of the Hammond Company, and am now scientific manager for Messrs. Crompton and Co. Whilst I was at Gateshead I saw the process of carbonisation: that is to say, I saw the carbons or filaments put in the crucibles and taken out again. The process of packing was then secret, but is so no longer. The process, when I first went there, was to pack each filament in charcoal powder with a little lampblack in it, in a little division in a thing like a water-colour palette. These palettes were then packed in the same powder in a large crucible, the lid of which was carefully looted down and then carbonised by very gradual raising to a high temperature. There are several important precautions to be taken in carrying out the process. The filaments are very liable to distortion. I heard Mr. Gimingham describe the frame which he employed for the purpose of preventing distortion. I recognised that frame as similar to the frames which I had seen at the Swan works. Mr. Alfred Swan, brother of Mr. J. W. Swan, experimented in this direction. The use of that frame is to prevent distortion, but the wood has another incidental action. The wood when carbonised slowly gives off large volumes of protecting gases, and these prevent the consumption of the filaments if graphite or stale charcoal is used. Mr. Swan made a number of experiments to obviate the difficulty of the contraction in the filaments during carbonisation; if left loose, distortion takes place, and it is therefore necessary to devise a frame which contracts at the same rate and at the same time as the filaments themselves. These methods of surmounting difficulties were certainly not known in 1879; various persons had been working upon the subject. Lane-Fox took out a patent, and so also did Mr. Swan, for some methods of carrying out these precautions. A practical filament could not be made without observing some such precautions. I have made a great many experiments in endeavouring to make filaments of thread. Some of these were made in 1883, not for the purpose of this or any other action. I wanted to bring out a lamp of some material which need not be parchmentised. I could not make a reasonably good filament. In 1884 or 1885 I renewed those experiments, using every modern improvement I knew of, and could not make a commercial filament from cotton thread not parchmentised. I did not try such things as camphor or oxide of zinc, regarding them, as a practical lamp maker, as mere nonsense. I have made experiments to discover the best modes of carbonisation. I once tried, in 1883, packing the crucible with pipe clay in the form of a fine sand. The filaments were destroyed, notwithstanding that I took every precaution known to me. Having been with Mr. Swan I did not care to use anything which he described, and he claimed packing with powdered charcoal in two patents. Therefore, I very much wished to devise some other method. I imagined several reasons why this experiment did not succeed—first, that no looting is perfectly air-tight, and that oxygen gets in through the cracks; the second, that there was a quantity of oxygen in the interstices of the sand which attacks the carbon filaments if it has no other carbon to attack; and the third, that there was probably water in crystallisation in the pipe-clay. A very small access of oxygen will spoil the filament. A filament may be perfectly ruined, and yet look all right to the eye. I have made experiments for the purposes of this trial within the last few days, with the view of ascertaining the quantity of water and oxygen to be obtained from sand. I heated red sand to a low redness in a gas retort; air and water came off. I calculated that there was enough water given off to consume completely some hundreds of modern filaments. At a red heat water would be decomposed by charcoal. I made a second experiment with another fine sand, which gave off enough water to consume some 25 to 50 modern filaments. I tried a third sand, of a grey colour, and found that it gave off more water than the first. I weighed and calculated the volume of water vapour; it was 27,000 cubic centimetres, enough to fill 27 large wine bottles. For the purposes of making Edison filaments, I do not think the use of sand would be a practical way. I do not think the way mentioned in the specification is a practical way of making a spiral. For one thing the copper would expand whilst the filament would contract. If the filament did get so far as to come out of the crucible whole, I think the workman would break it, or at any rate injure it, by revolving the copper. I made some experiments in 1881 in mounting carbons on platinum wires and carbonising the whole. I wanted then, if possible, to avoid the necessity of making the large ends seen in the Swan filaments. The platinum was acted upon by the carbon, and came out of a silver colour, and was very brittle and porous. I made a large number of other experiments upon the same subject in 1883. Some of the platinums were then made like frosted silver; others were quite black and very brittle. In many cases I employed glass to hold the platinums where I wanted them; at high temperatures the glass melted.

Mr. JUSTICE KAY: Could you carbonise filaments at a lower temperature than would melt glass.

WITNESS: I think so, my lord. From my experience I think it is a great mistake to carbonise platinum wires with the filament. I have examined those lamps which Mr. Gimingham produced. I agree, so far as I remember, with all that was said about them by Prof. Thompson. The deposit in the Swan lamp is very different from that of the Gimingham lamps. The blackness in the former is due to overrunning. The tests made by Mr. Gimingham of the lamps made by him were not fair tests. From his figures and by the look of the filaments I should say from 20 to 30 candles was the proper illuminating power of those lamps. Six candles was much below their proper capacity. If run at 20 candles their life would be much shorter. The chief purpose of parchmentising is to standardise the filaments. It is necessary to take care that the current does not increase unduly, also that the filaments do not increase in diameter unduly. Cheesbrough's object was to get carbon to increase the diameter by deposit, and the precautions needed in the other case were not necessary for this. The difficulty which the workman would have in carrying out Cheesbrough's would be to keep down the current and not to increase it. The carbon would increase in size and the current would increase at the same time, and increase too fast. I have made myself acquainted with Despretz's paper, and assuming one of the experiments there described to be an incandescent experiment, exactly the same thing would there occur as Cheesbrough mentions. The directions in Cheesbrough's specification would not be sufficient to enable a workman to apply the flashing process, but it would be sufficient to enable him to make carbons.

Cross-examined by Mr. MOULTON: Whether or not the temperature would fall if a carbon in Cheesbrough's process were left to itself would depend upon the source of electricity, would it not?—It depends in a way upon the source of electricity.

In a case in which the carbon was of some size and of low resistance, and the batteries of fairly high resistance, the temperature would fall very rapidly, would it not?—If Cheesbrough used the batteries and arranged them very badly what you say would take place.

I put this to you. Supposing Cheesbrough were operating with carbon of low resistance, and the batteries were of fairly high resistance, the temperature would fall very rapidly, would it not?—If you mean the resistance of the whole set of batteries, that would occur.

And then it would be necessary to take means to keep the temperature of the carbon up, would it not?—It would.

You have been suggesting that the resistance in Despretz's batteries was high?—I was asked concerning one case, and suggested that it might be.

Do you say, even taking Despretz's arrangement of batteries, the resistance would not be high?—High compared with what? I should take the resistance of the cells to be, perhaps, an ohm. If you work them out together you will get what the resistance of any set would be.

Do you suggest, if you were working with such a chain of batteries, say 100, that the temperature of the ordinary pencil of carbon would not fall rapidly?—Before I can answer you properly you must tell me how you intend the cells to be arranged.

Supposing when Despretz tries experiments of passing electricity through carbon, as you suggest he did, in a hydro-carbon gas, with 100 cells arranged like that, do you suggest that the temperature of the carbon would not fall rapidly as flashing went on?—In the case of carbon thread mentioned by him, it would not. If he took a thick carbon and arranged 100 cells in series, I have no doubt it would fall very quickly.

In Cheesbrough's time it was usual with those persons who did use carbon in lamps to use pencils?—I think so.

In such a case, supposing you were making a pencil from which other pencils could be cut, it would be necessary then, would it not, to take means that the temperature should be kept up?—No, I think not; because I don't suppose Despretz would use such an absurd arrangement of his cells at all.

I am putting to you a case of putting batteries in which the internal resistance is greater than that of the carbon?—If Despretz used batteries with an internal resistance of the whole battery greater than the resistance of the carbon he was treating the temperature of the carbon would fall.

And so if they were equal?—If equal to start with, yes.

Under those circumstances it would be necessary to take means to keep the temperature up?—It would.

Do you suggest that in 1879 it was not known that in order to conduct carbonisation carefully without destruction of the carbon you must put carbon powdered, or something of that kind, into the crucible?—From direct knowledge I cannot speak, for I was not in the trade then. I should think that was not known then.

Was it not common knowledge among chemists, for instance?—Oh, yes, among chemists.

The term carbonisation was a chemical term, was it not?—I am not sure that it was. I think it was used in connection with charcoal burning.

It was a well known term in connection with arc carbons and electrodes?—I should think so, although I do not know. Electrode people generally spoke of baking.

In both those cases, electrodes and arc carbons, it was well known that you must put in charcoal powder or something of that kind to prevent combustion?—I think not, but I am not sure.

You are not prepared to say it was not?—I am prepared to say I think it was not. I have no knowledge of it at that date. The connection in which I knew of carbonisation was that of gas making.

There you took pains to exclude the air?—Not much. You shut the retort.

Just take this in: "The whole is placed in a closed chamber free from air and subject to heat sufficient to fully carbonise the fibre and leave nothing but carbon." Should you have understood that?—I am not sure about myself. I knew very little about chemistry in 1879.

Do you say that anybody of ordinary chemical knowledge would not understand it?—A skilled chemist would probably know how to take some steps to carry out that process.

But any person with ordinary chemical knowledge?—I think not.

Was it not known that packing with carbon powder would protect the filament?—I doubt if it was; certainly not to lamp makers.

But were there any lamp makers at that time?—Yes.

In the commercial sense was there a single incandescent lamp maker on November 10th, 1879?—I believe there was. I believe, but am not sure, that Mr. Swan was a commercial lamp maker at that date.

I am dealing with the question whether or not there was any trade?—I do not think there was any great trade in lamps at that time.

About these frames; for using these frames the parchmentised thread was wrapped on in long lengths, was it not?—Yes, it was.

So that the contraction of the thread in those long lengths would require some shrinkage of the wood which kept the carbon rods apart?—It would.

If the filaments were made singly, and if they were cut before being carbonised, there would be no need for that, would there?—Do you mean putting cut filaments on the frame?

Cutting filaments and packing in charcoal in crucibles?—Filaments packed in charcoal in a crucible would get all sorts of queer shapes.

I am asking you whether you would need wood where you were making many filaments of various lengths?—In that particular case I should say it would not.

Therefore, so far as the wood is concerned, if you were making the filaments separately, you would not want wood at all. Would it be useless?—Not necessarily.

If it were used it would be no good?—Not if the filaments were supported at the ends. In Swan's case they did not use wood to carbonise separately, but used little pieces of paper.

The Court then adjourned.

WEDNESDAY, MAY 9TH.

The ATTORNEY-GENERAL intimated that he had consulted his clients and would now admit that the carbon conductor in Swan's lamp received its present shape before carbonisation.

Mr. FLETCHER MOULTON, Q.C., continued his cross-examination of Mr. JAMES SWINBURNE: Have you never heard of packing a crucible in carbon dust?—No, I think not, not for carbonising. I may have, but I think not.

Is not the greatest danger in carbonising in sand to be expected from the air which may get in during the heating?—If your sand contains clayey matter water will be given off by that.

But apart from that, broadly speaking?—Apart from the oxygen given off from the packing, the destruction in long carbonising is due to the oxygen getting through the luting.

You have spoken of putting the platinum wire into the plastic material before carbonisation. Do you suggest that that is not a practicable method of joining carbon wires?—It is I think, if you carbonise the whole at a high heat.

Is not this method of uniting the two and of carbonising with the platinum wire inserted, a perfectly practicable method?—With certain precautions it would be.

What precautions?—Not heating the platinum so high as to make it porous.

What do you think would be the effect at the melting point of copper?—I should think at that temperature, if you packed the wire, it would be injured.

I asked you several questions yesterday on the subject of flashing with regard to the Cheesbrough process, and you told me that the Cheesbrough process did not increase the life of the lamp with modern filaments?—I told you that flashing did not.

You were writing last year about modern filaments?—I was writing about every sort of filament that I could think of.

You were only writing about filaments that were being commercially used?—Of filaments that were being used, or that I thought might be used.

You wrote:—"Flashing then tends to make carbon that will run at the same surface temperature all over, which is not of necessity a carbon of uniform resistance. This is really what is wanted in a lamp, as the durability of a carbon depends upon its temperature, or rather upon the temperature of its hottest or weakest part." When you wrote that, did you mean to say that flashing would greatly increase the durability of a lamp?—No; I meant that flashing would greatly increase the durability of a lamp if a filament was not uniform to begin with. With many of the filaments I described flashing would be very useful in increasing the durability of the lamp.

And that would increase the efficiency of the lamp?—No; the term efficiency of the lamp, by itself, means nothing.

But do you mean to say that if it lengthens the life of the lamp it would not increase the efficiency?—In the popular sense of the word efficiency it would; in the technical sense it would not.

Has it not been shown that the use of this very method increases the actual brilliancy of the carbon with the same amount of heat, by as much as 30 per cent.?—I may explain that several lamp-makers hold some such opinion, but I believe none who are aware of the great work done abroad on the question of radiation would differ from me.

Re-examined by Sir HORACE DAVEY: When you spoke of efficiency, Mr. Moulton and you were at cross purposes; what did you mean by efficiency?—By efficiency I mean the ratio between the power absorbed and the light given out.

You were not speaking of durability?—No; efficiency relates to the instant of which you speak.

Why do you say flashing would not increase the durability of the lamp if the filaments were uniform to begin with?—I say it from my own experience. A uniform filament is injured by flashing. I have made experiments with flashed and unflashed filaments of the same sort, and have found that the lamp with the unflashed filament was more durable.

You have said that packing one crucible within another with carbon dust was known and mentioned in works on chemistry. Was that for carbonising carbon filaments?—No. I believe it was for protecting the carbon crucible from being destroyed. It is obvious to me now that the same thing might be done in carbonising filaments, but I do not think I have ever heard of it before.

Mr. ALEXANDER BERNSTEIN, electrical engineer, examined by Sir HORACE DAVEY: I have been engaged in electric light working for about ten years, and have manufactured incandescent lamps for the past six years. There is a lamp bearing my name, which is essentially a low resistance lamp. The burner is a straight rod of carbon, supported between two leading wires which are sealed into the glass, the glass being exhausted of air; the length varies between three-quarters of an inch and 2½ inches, and the diameter is usually ·04 of an inch, or $\frac{1}{25}$th. There are about 1,000 lamps similar to that produced in use at the present time. When in the United States in December, 1880, I was anxious to see an Edison lamp about which so much had appeared in the papers, but could not find one upon the market. The first time I saw Edison lamps was during the first exhibitions of them at Menlo Park in February, 1881. Those I saw were similar to that put in by Dr. Frankland, as seen by him at the Paris Exhibition. The platinum wires were certainly not attached to the carbon filament by means of putty. The filament was in the form of a loop. I have never seen a lamp made simply by the specification of Mr. Edison, and as a lamp maker I believe it is impossible to make a commercial lamp under that specification.

Cross-examined by Mr. ASTON: The first Bernstein lamps put up were erected either in August or September, 1886, at Northwich.

Have you not special provision for supporting your straight rod?—Yes, the joint is made in an entirely novel manner.

When this rod is rendered incandescent does it expand longitudinally, and contract when the lamp is out?—Yes, but not always to the same points.

And the platinum wires are themselves elastic?—They are.

Mr. BERNARD S. PROCTOR, of Newcastle-on-Tyne, said he had known Mr. J. W. Swan for forty years. During 1878 and 1879 was frequently in his company, and took great interest in his experiments, conversing with him and assisting him constantly. Mr. Swan made a point of showing him every step of progress he made in incandescent lamps. At a meeting of the Newcastle Chemical Society on December 19th, 1878, Mr. Swan exhibited a lamp which had broken down, explaining its construction to the meeting. That lamp was given to witness, who broke it to get at the smoky deposit on the inside. He had since put it together, and now produced it. It did not now contain the platinum wire or the carbon. The general construction of the lamp was precisely the same as that of the exhibit known as Swan's stick lamp. Witness was present at a lecture given by Mr. Swan at the Literary and Philosophical Institute at Newcastle on February 3rd, 1879, when Mr. Swan showed a similar lamp alight. It burnt steadily until it was designedly put out. The light could scarcely be called good in comparison with lamps of the present day. On March 27th, 1879, witness read a paper on "The smoke of an electric lamp" before the Newcastle Chemical Society, referring to the broken lamp produced. Both before and after Mr. Swan's lecture he saw other lamps at Mr. Swan's establishment. Many improvements were made in the lamps before November, 1879. Within a day or two of the lecture Mr. Swan pointed out that the lamp would not be permanently a satisfactory one; he was aware that it took a larger current than was necessary to render it fully incandescent, and also that the rigid connections of platinum, carbon, and glass were a source of weakness. He set to work to improve the lamp in those points. To use less current thinner carbons were to be employed, and the carbons were to be arched so as to avoid having platinum joints at opposite ends of the lamp. He saw probably hundreds of lamps at Mr. Swan's works, partly made by Mr. Swan, partly by Mr. Stearn, Swan supplying the carbons and Stearn mounting them and exhausting the glass. These he saw, some at Bell's Court, the others at Moseley Street, on premises belonging to Mr. Swan. These lamps were all incandescent lamps, containing carbon conductors, platinum leading wires, and a vacuum. The carbons were made in some cases from paper and some from threads; some were thicker at the ends where the platinums were joined. They varied in thickness, but thinness was aimed at, and they were all much thinner than the pencil of carbon used in the original lamp, and most of them were arched. Witness saw many of the carbon conductors out of the lamps, and should say that it was perfectly impossible to cut such carbons from gas retort carbon with a saw and file. He had seen many of the lamps running prior to November 10th, 1879. When two or three were burning together they did not all burn with the same luminosity; he supposed this was due to the varying sizes and resistances of the carbons. These carbons varied in themselves, bright spots being observable at certain points. As individual lamps many of them gave about 12 or 14 C.P. light.

He remembered Mr. Swan having a gas engine erected at Moseley Street, Newcastle, in the spring of 1879; he saw lamps before that time at Moseley Street and Bell's Court, and at Moseley Street afterwards; also saw lamps made by Swan at the Post Office at Newcastle. The carbons in these lamps were thin strips or threads of carbon which had been shaped before being carbonised. Some of them were about $\frac{1}{10}$th or $\frac{1}{20}$th of an inch wide and about $\frac{1}{50}$th of an inch thick, in the form of a strip. In point of size they were very similar to but rather narrower than the carbon in J. I. 3, one of the lamps made by Mr. Gimingham, when, as he said, following Edison's specification. Mr. Swan frequently showed him samples of carbons, and he remembered distinctly one of cotton thread, which possessed great elasticity, and in which the fibre was visible after carbonisation. Besides the staff at Mr. Swan's works, he had met several of Mr. Swan's relations, and occasionally other friends, when he had gone to see the lamps. Certain points in the manufacture of the lamps were regarded as secrets, but there were other points which were not kept secret; the simple fact of the lamps running was not kept secret, and it was perfectly well known in the town.

Cross-examined by the ATTORNEY-GENERAL: You were a partner of Mr. Swan?—I think that was subsequently to that. About that time I was in partnership with him in the preparation of opium and other similar matters, but not in making incandescent lamps; but I am not sure that that was or was not in 1879. I was one of his most intimate friends.

You knew Mr. Stearn in 1879?—I am not quite certain whether or not I knew him in that year. I probably saw him at Mr. Swan's before he came to Newcastle to work with Mr. Swan.

When were you first asked about these dates by anybody on behalf of the Brush Company?—I think the first would be somewhere about Christmas last.

Did you not know perfectly that through the whole of 1879 Mr. Swan was experimenting with reference to incandescent electric lamps, and intended to patent his discoveries upon them?—I believe Mr. Swan was experimenting with the view of patenting anything that he discovered which was patentable.

Had Mr. Swan a Sprengel pump at that time?—I think he had, but I cannot fix the date positively.

Is it not a fact that he had no glass-blowing machinery at that time?—I think that is so.

Was he not sending to Mr. Stearn carbons to have glass put over them and exhausted?—I think I have already stated that, as far as I understood, that was what took place.

Did not Mr. Swan tell you in October, 1879, or thereabouts, that he was afraid Edison would anticipate him?—I could not say.

Do you remember being shown a letter from Mr. Stearn refering to Edison's experiments in October, 1879?—I don't remember that.

Did it not come to your knowledge that Edison was working upon the same lines as Mr. Swan?—Yes, it came to my knowledge that he was working on similar lines.

Did you not talk over the possibility of his getting a patent for his lamp, or for a lamp?—Yes, we frequently talked it over.

In October 3rd, 1879, do you remember this from Stearn to Swan: "Have you seen the account of Mr. Edison's experiments in vacuo in this week's *Nature* and *Mechanic?* He has trodden so closely on our ground that if he has patented his process I am afraid he has anticipated you entirely." Do you remember that?—I cannot say that I do remember that. I know all these things were talked about, but whether at that date or not I cannot say.

Did not Mr. Swan tell you that Edison's experiments or trials did not mention carbon?—I do not remember that matter.

Will you undertake to say that a single lamp before Christmas, 1879, was lighted by Swan except from batteries?—My conviction is that the lamps round Mr. Swan's engine-house in the summer of 1879 were lighted by the dynamo machine and gas engine.

Will you undertake to say that you ever saw a lamp exhausted or a glass blown in Swan's premises until after Christmas, 1879?—I will not undertake to say so. My impression was that they were all exhausted and blown at Birkenhead.

Did you see several lamps that came back from Mr. Stearn in the year 1879?—Trusting to my memory for the date I think I saw many lamps come back.

Had not every lamp sent back by Stearn had the carbons broken?—I know a large number were broken, but I did not keep any record of how many.

What is the largest number that you saw that came back in the year 1879 which had not their conductors broken?—I have no means of telling you what number. My impression is gained very much from the array of lamps round the engine-house, and I believe there were frequently six, eight, ten, or twenty at a time.

If I suggest that it was in 1880 and not in 1879, will you undertake still to say that these lamps were running in 1879?—I have given you my conviction that they were running in 1879.

Had not some of those lamps copper coils inside the bulbs between the glass and carbon?—I do not remember copper coils.

Had they platinum caps enclosed in the ends of the glass?—I do not remember when the platinum caps were introduced.

Did not Mr. Swan tell you in December, 1879, that he thought Edison had been working on carbon?—I think about that time we learnt from a letter in the *Times*, reproduced in the *Pharmaceutical Journal*, that Edison was using carbon. At Mr. Swan's suggestion, I wrote to the *Times* and to the *Pharmaceutical Journal*, and stated that Mr. Swan had long before done the very things mentioned as having been done by Edison.

Were not some of those lamps which Mr. Swan showed you lamps in which there was carbonised paper?—I believe some of those lamps had filaments of carbonised paper.

And did you not know perfectly well that through the year 1879, Mr. Swan hoped to patent a carbonised paper incandescent lamp?—I believe that Mr. Swan hoped to patent the details of the manufacture of carbon-thread electric lamps. I don't think he ever anticipated claiming a lamp containing a carbon conductor, and made of glass only. He hoped to patent modes of obtaining cotton parchmentised and vegetable parchment filaments.

Did you not know perfectly well that through 1879 Mr. Swan was hoping to patent an incandescent lamp in which carbonised paper was to be the conductor?—I knew that towards the end of 1879.

With reference to that, do you suggest that Mr. Swan published to the world what he was doing prior to taking out his specification?—I mean to say that he did not mean to publish to the world the details of the vegetable parchment.

Will you pledge your word that prior to Christmas, 1879, any more than 15 lamps were ever in Mr. Swan's works, or in Newcastle at all?—I can only repeat my conviction that I saw more than that number earlier than that.

Excepting with regard to the lamp exhibited at the lecture, did you say one word at the last trial about having seen successful carbon lamps before November, 1879?—I do not remember what I said at the last trial, but my impression is that I saw several lamps burning successfully before that date.

Sir HORACE DAVEY pointed out that at the last trial Sir Richard Webster objected to certain questions put to the witness about this matter as not being within the particulars.

The ATTORNEY-GENERAL: You have said that all the lamps were vacuum lamps?—No; I think it is possible that an experimental lamp was tried with nitrogen; but Mr. Swan's practice was to use a vacuum.

Did not Mr. Swan tell you before November, 1879, that he was afraid he would never get over the wasting of the carbon?—I do not remember that he said anything of the kind.

Do you know where the carbons came from?—I believe Mr Swan prepared them himself. I saw carbons which Mr. Swan showed me unmounted, but never saw the process of carbonising carried out.

Did you not know that he got his carbons from Carré?—I think he told me that he got the carbon pencil of the original lamp from Carré, but I do not imagine that he got the paper carbons from him.

Will you pledge your word that prior to December, 1879, you ever saw a carbon lamp alight in Mr. Swan's place, either by battery or otherwise, for more than ten minutes?—I have already said I did.

Was it not the great difficulty which Mr. Swan experienced in getting contact between the platinum and the carbon?—It was.

Will you undertake to say that prior to Christmas, 1879, you saw a carbon lamp in Swan's works in the arched form?—I believe I did. I will not go beyond my conviction.

Re-examined by Sir HORACE DAVEY: You had some conversation with Mr. Swan, in consequence of which you wrote to the *Times* newspaper and to the *Pharmaceutical Journal*?—Yes. I stated that the discoveries and inventions of Mr. Edison had been forestalled by an English electrician and pharmacist, who more than twenty years before expressed to me his conviction that incandescent lamps would ultimately prove better than the electric arc, and that carbon would probably be the best material to be rendered incandescent for the purpose; that he had worked for some time upon the subject, and that I remembered many years ago taking up one of his paper carbons under the impression that it was a watch spring.

Mr. Swan's patents were for details?—I believe the use of parchmentised paper for carbons was one special detail to which he attached importance. The specification of January 2, 1880, was not for a lamp, but for details.

Did Mr. Swan, so far as you know, ever propose to take out a patent for an incandescent lamp as a novelty?—Pure and simple? I do not think he did.

Mr. ARTHUR WEST HEAVISIDE, Superintending Engineer of Postal Telegraphs at Newcastle, examined by Sir HORACE DAVEY, said he knew of the existence of a gas engine at Mr. Swan's in the late summer of 1879, and to the best of his belief he saw it at work at that time. In that year Mr. Swan came to him with reference to a difficulty he had experienced with regard to the amount of power he was using in running his lamps, and witness was able to tell him how much current he was using and what the resistance of the lamps when cold was. It was a matter of conversation between them that it was necessary to make the filaments as thin as possible and of as high resistance as possible. During the months of August, September, and October Mr. Swan brought lamps to witness's battery room having horseshoe-shaped, thread-like carbon conductors, which were connected up to bichromate cells, and the effect observed, with the view of testing how much current was necessary to run the lamps satisfactorily.

The Court here adjourned for the day.

(To be continued.)

[On Thursday several witnesses from Newcastle were called, and spoke of having seen lamps early in 1879 at Mr. Swan's, containing thin carbon filaments of horse-shoe shape. These were run from a dynamo, and gave good light. An apprentice and assistant of Mr. Swan, the son of an earthenware manufacturer, gave evidence of having taken crucibles packed with charcoal dust, and containing strips of paper, to be baked in his father's ovens at Gateshead.]

NOTES.

Central Station Lighting in America.—The Edison Electric Light Company of Philadelphia is erecting the largest station for lighting in the States. The land on which it is built is very valuable, and it was necessary to limit the area to 70 feet by 100 feet. In order to get the required space, the building is carried up 114 feet above the pavement, and is divided into six storeys. On the ground floor will be located 20 engines of 250 I.H.P. each. They are of the Armington-Sims type, running at 200 revolutions per minute. The foundation for the engines will be practically solid with the concrete foundation of the building. On the second floor will be 40 dynamos of 1,500 lights each, making the total capacity of the station 60,000 16-C.P. lamps. The dynamos will weigh about 7 tons each, and will run at a speed of 650 revolutions per minute. On the third floor will be the workshops, where wires and conduits are prepared for laying in the streets and making connections with the houses. On this floor will also be located the two blast fans, driving 50,000 cubic feet of air per minute into the furnaces. The products of combustion will be discharged by means of two shafts, 9 feet in diameter, and so built on either side of the house as to resemble huge bow windows starting from the third floor. On the fourth floor will be placed the boilers. Their rated capacity is 5,000 H.P., and they are to be of the Abendroth and Root tubular pattern. The smoke will be discharged downwards into the flues on the third floor, and the ashes, which will fall into pyramidal ash pans, will be discharged into cans on the same floor. On the fifth floor there is storage cagacity for 1,000 tons of coal. The arrangements are such that on the first floor the coal waggons are driven on to scales. After being weighed the coal is discharged into shoots, delivering directly into elevators, which carry it to the fifth floor, where it is shot into the bins. Arrangements are made for delivering the coal directly in front of each boiler. On the sixth or top floor will be the general offices of the company. The distribution is to be on the three-wire system, and there are 35 mains leading out of this station. The company has already expended £40,000 for copper conductors, and 11 miles of street mains have been laid, leaving about 20 miles more to cover the district. This quantity will be laid during the coming summer. The station when finished will cost £200,000. Arrangements have already been entered into to furnish upwards of 10,000 lamps, and the company intends furnishing power in any quantity that may be desired up to 100 H.P.

Electric Light in Florida.—The electric light installation in the Ponce de Leon Hotel, at St. Augustin, Florida, is one of the largest in America. The plant consists of four multi-tubular boilers of 107 H.P. each, four Armington-Sims engines of 60 H.P. each, and one of 125 H.P. Each of the smaller engines drives a No. 16 Edison dynamo. There are 5,500 incandescence lamps fitted up on the Edison system of distribution.

Electric Light at Torquay.—We learn that the people of Torquay are determined te have the electric light, if it is possible to get it at a reasonable price, and there appears to be a promise that it will be offered them at as cheap a rate as gas.

Church Lighting.—The Rev. H. C. Wilson's Church at Eastbourne has permanently adopted the electric light. This church is always densely crowded at the evening service, but the building remains delightfully cool.

Electric Lighting in Vienna.—Vienna has now in use about 18,000 incandescent lamps, and 1,000 arcs.

Electric Lighting Act.—The Electric Lighting Act (1882) Amendment Bill was read a second time in the House of Commons on Monday night.

Electric Lighting in Kensington.—At the meeting on Wednesday last week of the Kensington vestry, the committee recommended that sanction be given to the Kensington Electric Lighting Company for laying wires in the sewers as a temporary measure, on proper security being given in case of accident, the vestry's solicitors to prepare a contract at the expense of the company, and on condition that the work is carried out at night in places where interference with trade, &c., would otherwise result, and that it be executed to the satisfaction of the vestry's surveyor.

Telephone at Blackpool.—The Blackpool Town Council has decided to accept the tender of the Lancashire and Cheshire Telephone Exchange Company for the fixing of telephones between the various corporation offices.

Telegraphic History.—We recommend those who are studying the early history of telegraphy to read an article by Franklin Leonard Pope in the *Century Magazine* for last month. The article is interesting, and contains illustrations of the telegraph instruments designed by Morse and Alfred Vail between 1837 and 1844.

Repairing Channel Cables.—The Submarine Telegraph Company's steamer, the *Lady Carmichael*, has just proceeded to sea again after one of the longest voyages she has ever made, extending over a period of nearly five months. The vessel has now gone to repair certain cables in the Channel after being in the harbour only a little over a week. She had then returned from the North Sea, where her presence had been required since December, owing to the difficult task of repairing the company's cables running across to Germany. The greater part of the time the weather was so extremely rough that the connections could not be made.

Aristocratic Electricians.—The description given by Viscount Monck of the troubles to which the Brazilian and Submarine Telegraph Company has been subjected over its cables is highly amusing, and whoever coached him up has turned out a creditable pupil. How that new cable must have enjoyed the fun, knowing all the while that the fault rested entirely with its old companion, who also appears to be a bit of a wag in his way!

The Telephone in Kent.—The progress which is being made by the South of England Telephone Company in East Kent is slow but sure. For sometime past the company has had the necessary number of guarantees for a branch from Canterbury to Dover, but a considerable period has had to elapse to enable the company to get all the consents to carrying the trunk wire from Canterbury to Dover. The greater part of the difficulties has now been overcome and it is proposed to commence running the wire through between these two towns by way of the London road almost at once, and on Tuesday the Town Council granted an application to erect poles for the same in the Borough. When the work is commenced it is calculated that it will take nearly or quite two months to lay the trunk wire. The company proposes to extend their system to Faversham, Ashford, and Deal, as soon as enough subscribers have "signed up," but in these towns, except Deal, which seems to have been ignored, subscribers appear to be very difficult to get. The company is asking in other towns £15 per annum for the same privileges which they propose to give to Canterbury—which is to be made the Central Exchange—for £10, and this is having a decidedly detrimental effect in the way of obtaining subscribers.

The Telephone in a Coal Pit.—The Empire mechanical telephone is being employed at the Camerton collieries for the purpose of affording communication between the bottom of the pits and the surface. Messrs. Davis and Sons of Bath carried out the installation.

The Writing Telegraph.—In the House of Commons on Friday last Mr. M'Ewan asked the Postmaster-General if his refusal to grant a licence to the proprietors of the writing telegraph was indicative of a resolution to depart from the position taken up by the Government as defined by Sir Henry James (then Attorney-General) on November 29th, 1880, in the case of the "Attorney-General *v.* the Edison Telephone Company (and others)," now United Telephone Company (specially reported for the TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW, December 15th, see Vol. VIII., page 425), as follows:—"There is no desire on the part of the Crown to check invention. I most emphatically disclaim that. Inventors and companies will always be dealt with in a liberal spirit if they consent to become licencees of the Crown;" and further, in the same case, the Attorney-General said (see *Engineering*, Vol. XXX., page 514), "The Government has no wish whatever to stop energy for increased knowledge in telegraphy, the sole object of the Crown on the present occasion being to obtain an order for a compulsory licence upon all persons who should use the telephone;" and if that action did not arise in consequence of the telephone company having refused to become licencees; whether his attention had been called to the statement of the Attorney-General, on his application to two Judges of the High Court on April 11th, 1881, to vary the decree (see TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW, Vol. IX., page 149), "The litigation has now come to an end. When once the claim of the Crown to the monopoly was admitted they would be ready, in the interests of the public, to grant licences, so that there might be no impediment in the way of the active carrying on of the telephonic communication;" whether, seeing that the proprietors of the writing telegraph only asked to become licencees of the Crown, he would state on what grounds they were refused to use their telegraph system; and had he discretionary power to alter the principle on which Government had declared its intention to deal with inventors and companies as in the Edison case. Mr. Raikes said: In reply to the hon. member I have to say that the declaration which his question gives in the first person is not a quotation from the report in the TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW of December 15th, 1880. That report is a condensed account of the proceedings, and is given in a narrative form in the third person. The report in *Engineering* is also a mere condensed account. I can cite nothing in the shorthand writer's notes which conveys such an impression as the hon. member has received. I may further say that the then Postmaster-General did not, on the judgment being given in his favour, immediately concede a general licence even to those who were parties to the case before the Court. He freely exercised his discretion, refusing a licence here and granting a licence there. I have on a previous occasion stated to the hon. member that the Government has never assumed the position of granting indiscriminately a licence to every inventor of a new form of apparatus. I have also informed him that if there is a substantial demand for the establishment of exchanges to be worked by the instruments of the Writing Telegraph Company I think it preferable that they should be in the hands of the Post Office, the instruments being supplied by the proprietors on terms to be arranged. To both these statements I still adhere.

The Telegraph of the Future.—Mr. Patey, permanent secretary of the Telegraph department of the Post Office, in giving evidence before the Select Committee of the House of Commons on Tuesday, on the Revenue Departments Estimates, stated that in the course of years the department must look to a great expenditure on underground wires, not in substitution of the overground system, but in addition to it. The present cost of annual extension of telegraphs was about £100,000 a year, but the laying down of the first underground wires would cost 10 times as much, and each succeeding underground wire would *per se* cost more than one overground wire.

The Royal Society.—The annual conversazione at Burlington House took place on Wednesday evening last, and among the usual attractions were a number of interesting electrical exhibits. Professor A. W. Rücker, F.R.S., and Mr. C. V. Boys showed the means employed in optical demonstrations of electrical stress, which are similar to those of Dr. Kerr. In the same room was Mr. James Wimshurst's large influence machine, which is self-exciting in any condition of atmosphere. This machine has 12 discs of 2 feet 6 inches diameter, and with Leyden jars it is said to give sparks 13½ inches in length. The Royal Meteorological Society exhibited photographs of flashes of lightning taken in various parts of the world, and Dr. Marcet, F.R.S., illustrated flashes of lightning by throwing electric sparks from the Wimshurst machine upon a screen in greatly magnified form. Professor George Forbes's coulombmeter, Robertson's writing telegraph, and Mr. Eric Bruce's electric signal balloon were among the objects of electrical interest. Messrs. Woodhouse and Rawson had several exhibits, consisting of Vernon Harcourt's standard lamp; a new microphone button: samples of adamantine carbon; and their new chemical pole indicator, which shows the relative poles of an electric generator when one of the electrodes of the indicator assumes a bright red colour. Miner's lamps were exhibited by the Edison and Swan United Electric Light Company, and by the Schanschieff Electric Light and Power Company. Messrs. Drake and Gorham's electric lantern was used for views illustrating the progress made with the erection of the great steel cantilevers spanning the 1,700 feet wide openings of the Forth Bridge, also for lantern views of the interior workings of a colliery. A Brockie-Pell arc lamp was inserted in this lantern, the light from which was exceedingly steady and perfectly silent.

The Royal Society Fellows.—The following candidates have been selected by the council of the Royal Society to be recommended for election into the society. The ballot will take place on June 7th. Mr. T. Andrews, Mr. J. T. Bottomley, Mr. C. V. Boys, Prof. A. H. Church, Prof. A. G. Greenhill, Sir W. F. D. Jervois, Prof. C. Lapworth, Prof. T. J. Parker, Prof. J. H. Poynting, Prof. W. Ramsay, Mr. T. P. Teale, Mr. W. Topley, Mr. H. Trimen, Prof. H. M. Ward, and Mr. W. H. White.

Wire Machinery List.—Messrs. Barraclough & Co., Limited, of Manchester, have issued a new list of electric wire machinery, which will probably interest many of our readers. Much of the matter relates, we are informed, to machinery made specially by the company, and in which during the last few years they have introduced important improvements.

Wonders will Never Cease.—While the proposed Institute of Medical Electricity, to which we drew attention some months ago, is still being gravely considered, there are other people with talents worthy of a better cause, who strike while the iron is hot. What will our readers think of the "British Association of Medical Electricians," the registration of which is announced elsewhere in our columns. The experimental researches of Mr. Harness, for instance, or a paper by Professor Carter Moffatt, of ammoniaphone fame, would create a buzz of excitement in the scientific world such as we have been unaccustomed to of late. Everything considered, we really cannot help coming to the conclusion that nothing succeeds like success—we mean audacity.

Incandescent Lamps in London.—The City Liberal Club this week entertained at dinner a number of gentlemen, some of whom are, we imagine facetiously, stated to be the leaders of scientific research in the Metropolis. We are of opinion that to the majority of those present the meaning even of the word science is not quite clear; but we are digressing. Mr. Swan, who happened to be present, stated that over a quarter of a million incandescent lamps were used in London every night. We are getting on.

Errata.—In our report of the discussion on Mr. R. E. Crompton's paper on Transformers *v.* Accumulators, Mr. W. B. Esson's remarks should be read instead of "mains to distribute from four centres at an aggregate of 600 volts," "*mains to distribute from four centres an aggregate current of 6,000 ampéres*," and instead of "there are two systems of distribution before us—one by mains at low potential, 100 volts, and the other at high potential, 2,000 volts," read "*there are two A.T. systems of distribution before us, one with a few transformers having distributing mains at 100 volts, the other with transformers in each house having a charging network at 2,000 volts.*"

Personal.—We learn that Mr. Arthur Shippey is at present resident in Washington, U.S.A., where, for the past few weeks he, in conjunction with Dr. Woodward of Toronto, and Mr. John Bilton of New York, are amongst the daily visitors to the United States Patent Office, where they are reported to be busily engaged in examining into the various records and models filed in the American Patent Office in connection with electricity.

We are informed that Mr. A. Le Neve Foster, formerly of the India-Rubber and Gutta-Percha Company at Silvertown, has joined the firm of Messrs. Davis and Timmins, Ltd. Mr. Foster is so well and favourably known in electrical circles that any comment from us on the advantages of this connection would be superfluous.

Messrs W. T. Glover & Co. inform us that Mr. Basil Gee has taken charge of their London Sales department for cable and wire.

The Lighting of Billiard Rooms.—A correspondent writes:—"Having had thirty years' experience of billiard life, I venture to give my opinion as regards lighting billiard-rooms by electricity in preference to gas. It was thought some few years ago an impossible feat to light a room satisfactorily in this way, and I also shared in that opinion; but this system has lately been adopted in a new room, and is in every way advantageous on the score of cleanliness and cost, and what is still more important, *health*. Had this been known and acted on sooner, it might have prevented the loss of many lives of those players and markers who have succumbed in consequence of the foul atmosphere arising from burnt gas, more particularly in the winter months. Under the new system my room is as cool at the end of the evening as it is at the commencement, and customers who patronise the table speak in the highest terms of the comfort of the room. I may further add that the whole of the establishment is lit up in the same manner."

The Bradford Lighting.—The *Leeds Mercury* of the 9th inst. states that at a meeting of the Bradford Town Council, Ald. Fredk. Priestman said he had expected to be able to bring before the Council a resolution accepting tenders for the execution of the works for electric lighting; but it was found necessary to extend the period during which tenders might be sent in. No less than 61 tenders had been received for the whole of the work, inclusive of buildings, and 140 for sections of the work. An unexpected difficulty had arisen. As a mere matter of form, the Town Clerk applied to the Local Government Board, and the officials appeared to have taken up the question *de novo*, demanding answers to all sorts of questions, and would perhaps send an inspector down to see whether the works were necessary or not, although the Corporation had authority under an Act of Parliament to undertake them. At present, therefore, they were at a deadlock in the matter, and he was afraid they would not get over the difficulty till a deputation went to see Mr. Ritchie. Personally, he had no doubt it was the action of some official who thought he must do something for what he got.

The Elieson Locomotive in America.—Lecturing before the Buffalo Electrical Society recently, Mr. C. S. Morton, who, it will be remembered, took the Elieson locomotive to America, said the Elieson system worked under many disadvantages in Buffalo, the motor not having been designed for the work it had been called upon to do, the grades being very heavy, the curves numerous and of small radius, and the track of a form unsuited to mechanical traction. By careful working, however, all these difficulties had been overcome, and the locomotive had done most satisfactory work, and had not upon any occasion declined to accomplish any task it had been put to.

The International Society of Electricians (Paris).—At the general meeting of this Society, held on April 11th, M. Paul Lemonnier was elected President (*vice* M. Mascart), and MM. Jules Carpentier and C. M. Gariel Vice-Presidents.

The Copper Market.—From the reports of home and foreign markets it would appear that consumers are still holding aloof; the stock is consequently rapidly increasing. Signs are not wanting that the copper market will before long follow the downward movement shown in tin.

The School of Electrical Engineering and Submarine Telegraphy.—A very satisfactory report has just been received by the managers from the external examiner, Mr. H. R. Kempe, of the G.P.O., showing that out of 14 students of the advanced class who went in for the final examination held on April 18th, in which 70 per cent. of the marks is required, eight obtained the vellum certificate with the following percentages:—H. F. S. Crawford, 94·6; A. H. French, 88·6; T. W. Watts, 88; A. O. Jensen, 87·3; H. A. McCausland, 86; E. L. Simpson, 85·3; E. H. Greg, 80·6; A. E. Beddoe, 71·3. About two months ago, as the result of an examination in engineering, the following students also obtained the vellum certificate:—L. M. Green, 97·3; H. E. Taylor, 97·3; P. T. Heath, 90·6; H. A. Twine, 88·6; R. Cotton, 87·3.

The Ball Dynamo.—We have received a pretty little catalogue illustrative of the progress of the Ball electric light system. Mr. Chas. W. Raymond, who is probably still kept in mind by many of our electric lighting friends, retains his position of general western agent for the system, which appears to be growing in favour in many parts of America. The Company refers to nearly 200 installations, in many of which an increase has been made in the plant originally erected.

A Pardonable Error.—A correspondent, whose mistake may, under the circumstances, be to some extent excused, writes:—"Perhaps you can explain how it is that in one of your contemporaries of May 4th, so much prominence, and so considerable an amount of space, is devoted to remarks upon a dinner given by Lord Wolseley to Sir John Pender and other gentlemen interested in politics, trade and finance. I had imagined that the journal in question was dedicated to purely scientific and technical matters; but judging from precedent, we may expect to find in so-called scientific publications some such announcements as—'The amiable chairman of the Oriental Wire Company last night entertained at a sumptuous banquet His Ethiopian Majesty, King Ja-Ja and suite. Among the after dinner speeches His Majesty, in a brief and fairly lucid address, commented strongly on the indifferent quality, from a culinary point of view, of the class of missionary lately supplied to the coast. In proposing the health of the donor of the feast, he trusted that the well known ability in wire pulling of the worthy chairman of the Oriental Wire Company might be exerted in the direction of improving the class of material he referred to.'" We are sorry we are not in a position to give our correspondent the explanation he desires, as the ways of journalists are sometimes as inscrutable as those of Providence.

Brussels Exhibition.—It is almost certain that the proposed scheme of electric lighting at the Brussels Exhibition will be considerably modified, from economical motives.

Failure of Conductors.—The system of underground conductors adopted by the Electric Lighting Company of Saint-Etienne has proved a failure, inasmuch as the subscribers have been compelled to resort to the use of gas. We learn from *La Lumière Electrique* that the conductors consisted of copper bars enclosed in pipes and insulated with an asphalte composition. We believe that this method closely resembles the Edison system.

The Most Powerful Electric Light in the World.—According to Captain J. Sidney Webb, of the Trinity House, the light at St. Catherine's Point, Isle of Wight, will be the most powerful electric light in the world.

Underground Cables in Philadelphia.—The engineer to the Philadelphia Town Council, Mr. D. R. Walker, has just sent in his annual report to the Mayor, describing the behaviour of the underground cables, which are used for telephonic, telegraphic, and electric light service. There are four companies in Philadelphia now using Waring underground cables, viz., the Brush Company, the Keystone Company, the United States Company, and the Underground Electric Light and Power Company. The Brush Company is using 60 arc lamps in one of its circuits, which is five miles long, and is worked at a pressure of 2,800 volts, or about 45 volts per lamp. The lamps are generally placed at intersections of streets, and at a distance of about 500 feet apart. The cable for the Brush lamps consists of a 7-strand 14 B.W.G., with insulation of from $\frac{1}{16}$ inch to $\frac{3}{32}$ inch, and protected with a lead covering $\frac{1}{8}$-inch thick. The same cable is used by the Keystone Company in a 15-mile circuit at 2,000 volts, and no difficulty has been found in working it. Along Chestnut Street the electric light cables are laid side by side with telephone and telegraph cables in a cast iron duct 20 inches by 30 inches. In Broad Street the cables are laid in a wooden trough, covered with a plank and close under the pavement. According to the report, nine-tenths of the difficulties experienced with underground work were not in the cables themselves, but in the connections with the overhead portions. Mr. Walker also mentions an interesting case where lightning struck an overhead connection on an underground circuit, ran through three miles of cable, and burned the dynamo; the cable itself, however, was not injured.

Gill's Electric Light Switch.—The special feature of this switch, which is designed to carry from 150 to 200 ampère currents, is the arrangement of the various parts, which enables those portions which are liable to wear (especially from sparking) to be readily removed and replaced; this is a feature which we believe is not possessed by other switches. The contact into which the end of the lever moves is a spring clip, the spring and clip piece being easily removable; the end of the lever also which engages into the clip can be unscrewed and another piece substituted when the same is burnt or worn away. The whole make of the switch is very substantial and the action very good.

Public Electric Alarms.—A novel kind of clock is now being erected at Margate in the Jubilee Clock Tower as a fitting completion of the memorial. Sufficient funds have been subscribed and a tender has just been accepted for the work. The novel feature of the clock is an electrical apparatus which will give an alarm to the inhabitants at certain hours of the day.

Electricity in the Royal Navy.—Orders have been received at Portsmouth for the work of installing the electric light on board the Royal yacht *Osborne* to be commenced forthwith.

Electrical Enterprise at Bournemouth.—A motion has been given notice of by a member of the Bournemouth Commissioners to the effect that sanction should be given to the application of Messrs. Phillips, Harrison and Hart to the Board of Trade for a license to supply electricity within the Bournemouth district. The matter has been referred to a committee of the whole board.

The Schanschieff Electric Light and Power Company, Limited.—It is stated that a petition has been presented by Mr. Barber-Starkey for the revocation of a patent proposed to be purchased by the above company. An application has been granted by Mr. Justice North to allow the case to stand over to enable the company to prepare evidence, and the case has been placed in the witness list for trial.

Fire Alarms.—An alarming fire broke out in the timber yard of Messrs. Calder, Dixon & Co., Middlesbrough this week, and before it was overcome effected very considerable damage to both plant and stock. At noon the premises were inspected by the watchman, and were apparently safe, but hardly five minutes had elapsed before he observed smoke issuing from the shed, and discovered, on investigation, that a considerable quantity of waste timber was in flames. An alarm was instantly raised, and telephonic communication between the Market Place, Police Office, and the fire brigade authorities effected. The whole of the contents of the shed, which are estimated at several hundred pounds, were destroyed. The fire alarm instruments employed were of the manufacture of Messrs. Cox-Walker & Co.

The Copenhagen Exhibition.—The Northern Industrial, Agricultural and Art Exhibition in Copenhagen will be opened by the King, Queen and Royal family on the 18th instant. This exhibition will be by far the largest and most important that has ever been held in Scandinavia. Besides Denmark, Norway and Sweden, which countries will be very largely and of course principally represented, there will be English, German, French and Russian divisions. The grounds, which include the Tivoli Gardens, the Engine Department, the Fishery Court, the Gardeners' Court and the Army and Navy Department will all be lighted by the electric light. The installation will consist of 12 large arc and 300 incandescent lamps, which are to be fed by dynamos of the Edison, the Siemens, the Jürgensen and the Schuckert types, and the driving power for all will be produced by means of steam engines indicating about 100 H.P.

NEW COMPANY REGISTERED.

British Association of Medical Electricians.—This is an unlimited company without specified capital, formed to promote and encourage the study and practice of medical electricity, for which purpose facilities will be afforded for the reading of papers, the delivery of lectures, the prosecution of experimental research, and for the free interchange of experiences of those engaged in the study of medical electricity and of allied sciences. Every annual member is to pay a subscription of one guinea. The subscribers are C. B. Harness, Potters Bar, consulting medical electrician; J. F. Leeson, R.L.C.P., Brighton; H. C. Risborough, 1, Maley Terrace, Lower Norwood; C. P. Hollier, Oak View, Streatham, consulting electrician; J. H. Hodges, 16, Great Ormond Street, medical electrician; Professor Carter Moffatt, Northumberland Park, N.; A. Smith,

1, Rathbone Place. The business of the association is to be managed by a council. Registered 5th inst. by Charles Dobble, 14, Serjeant's Inn, Temple.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Manchester Electric Supply Company, Limited.—The statutory return of this company, made up to the 19th July, 1887, was filed on the 30th ult. The nominal capital is £10,000 in £10 shares. 82 shares have been taken, upon which £5 per share has been called. The calls paid amount to £335, leaving £75 unpaid. Registered office, 31, Market Street, Manchester.

Anglo-Portuguese Telephone Company, Limited.—The annual return of this company, made up to the 2nd inst., was filed on the 3rd inst. The nominal capital is £75,000 in £1 shares. 50,000 shares have been allotted, and are considered as fully paid. Share warrant of 10 shares, representing £4,020, are outstanding.

Bournemouth Electricity Company, Limited.—The registered office of this company is at 15, Town Hall Avenue, Bournemouth.

Dalmatia Mining and Electric Power Company, Limited.—An agreement between the Dalmatia Mine, Limited, and this company, provides for the purchase of mining property, with machinery, plant and certain erections situate in Kelsey mining district, El Dorado, California, for 30,000 fully paid shares in this company.

CITY NOTES, REPORTS, MEETINGS, &c.

Submarine Cables Trust.

SIR JAMES ANDERSON presided on Tuesday at 2 o'clock over the annual meeting of shareholders in this trust at Winchester House, 50, Old Broad Street. There was a small attendance.

The secretary read the notice convening the meeting, and the minutes of the last meeting.

[The report, which was taken as read, appeared in our last issue.]

The Chairman said: I have very few remarks to offer, but there are some that will perhaps give a clear exposition of the report. Our revenue for the financial year just terminated has been, as you will see from the report, £17,945 as against £14,528 the previous year. In 1887 we brought into the accounts the large balance of £2,140, whereas we began this year with a balance of only £95. In both years we have paid at the rate of 4½ per cent., but we carry forward a balance of £1,448, which, as stated in the report, is equal to an additional 8s. 6d. per cent. The interest payable is cumulative. Our revenue has not enabled us to pay interest beyond the coupons due in October. The trust deed, under which we work, provides that the interest shall be payable half-yearly, viz., on the 15th April and the 15th October. If we distributed the balance of 8s. 6d. at once the interest would have to be paid in three instalments instead of two as we try to pay it, because in October next we shall have sufficient funds to pay the outstanding £2 11s. 6d. To avoid the inconvenience of paying one coupon in three instalments we propose to hold the money in hand till October 15th, when we propose to pay £2 10s. and the balance of 10s. on January 15th. In April next year we shall pay as much as possible on the October coupons, and of course due notice will be given. In the report we refer to the falling off of traffic, mainly, of course, due in regard to our investment in Anglo-American stock, and I am sorry to say I do not know of anything to add as to the prospects of improvement. The main hope of the company is in the Eastern Extension, of which we hold a large amount of stock, paying very fair dividends, and that keeps matters up more than what we might expect. By and bye, if the companies come to some agreement, we ought to be flourishing again, but until then we cannot do otherwise than we are now doing. The only question now is whether we should pay the coupons by two or three instalments. The three instalments is a very inconvenient plan, and hardly worth while. We therefore prefer the two. With these remarks I propose that the report and accounts of the trustees now submitted to the meeting be approved and adopted.

This motion was seconded by Viscount Monck.

In response to the chairman's request for any remarks—

Mr. Wetherby said: I dare say I am not sufficiently conversant with the accounts, and therefore may be in error, but I see that £11,636 is said to be lying at Glyn's on dividend account. Does that refer to the amount already paid? because it is a curious thing that the accounts are made up to April 15th, 1888, but there is included £3 per cent. paid April 16th, 1888. I think your accountant should have his attention drawn to this, that the accounts are supposed to be made up to the 15th, yet you show a payment made on the 16th.

The Secretary: That is owing to a Sunday intervening.

Mr. Wetherby: Then it is a fact that the accounts were not made up to the 16th?

The Secretary: We are bound to make them to the 15th April.

Mr. Wetherby: Is that amount still to our credit that the interest of £3 was paid on the 16th April? I want to know whether that £11,636 is still lying at Glyn's?

The Secretary: It was lying there on the 15th April. Then it was transferred to the coupon account. Now, there is a balance of only £1,448 as you will see by the balance-sheet.

The adoption of the report was then put and carried unanimously.

The re-election of auditors was next moved at a remuneration of £25 a-year, and adopted.

Mr. Wetherby expressed a hope that the Board would remember the necessity of keeping expenses down as much as possible, remarking that he did feel this in reference to the telegraph companies which were interwoven one with the other, that a Board which might happen to be associated with several other companies should endeavour to keep the expenses down. He, at the same time, proposed a vote of thanks to the directors. This was adopted, and

The Chairman said: I am much obliged, gentlemen, for your confidence. As to the matter of expenses, we do try to keep them down, in fact they are the subject of our perpetual watching every day.

The proceedings then terminated.

The Brazilian Submarine Telegraph Company, Limited.

THE twenty-ninth ordinary general meeting of the shareholders of this company was held in Room 174, Winchester House, 50, Old Broad Street, London, on Wednesday, the 9th inst., at twelve o'clock noon, to receive the report of the directors and the accounts to 31st December, 1887. The Right Hon. Viscount Monck (chairman), presided, and a few shareholders were present.

The Secretary read the notice convening the meeting, and also the minutes of the last meeting, which were confirmed.

The report, which was given in our last issue, was taken as read.

The Chairman said: I presume you will take the report as read, and it becomes my duty to move its adoption. This, I think, is the 29th half-yearly meeting we have held of this company, and on every occasion when I have met you in this room or elsewhere, I have been able to give a pretty satisfactory account of the state of your affairs. I am happy to say that now there is no exception to the rule. Your plant is in an excellent condition, and your revenue is increasing every week. Your expenses are diminishing, and we are paying off the debenture debt which we were obliged to contract in order to pay for the reduplication of the cable. The expenses during the last half-year which we are now considering show a decrease of £449 on the corresponding half-year. That decrease is not, of course, very much; it is impossible to work an additional traffic without incurring at least nearly as much expense; but it is a decrease, and it shows your directors are endeavouring in every way to save money for your profit. The amount of debentures paid off and drawn for redemption is £51,000, leaving a balance of £99,000 still due, which, if our affairs continue to prosper, we hope to pay off in due course, and leave you entirely without that debt. (Hear, hear.) I said above that the plant was in perfect order. There is one exception; a small fault which has developed itself a few miles from Pernambuco, close in shore, which does not interfere in any way with the working of the cable, and can easily be removed, the only obstacle to doing so being the distance it is from home, and we have no ship on the spot. However, we have made arrangements for a ship to go thither and repair the fault. During the last half-year a fault had shown itself in one of the cables off Madeira, and in repairing it we had a very peculiar experience. At Madeira the two cables are conducted up a precipitous rock to the cable-house at the top. There was a tremendous hurricane there last spring, which blew the cables about, and we were obliged to do some repairs. We thought there was a fault in the new cable, but afterwards discovered it was in the old one, and we had no difficulty in repairing it, and setting it right. On drawing up portions of the old cable it was satisfactory to note that it was in as good condition as when laid fourteen years ago, and in perfect order. (Hear, hear.) I beg to move that the report and accounts of the directors to 31st December last, now submitted, be approved and adopted.

Sir James Anderson (vice-chairman) seconded the resolution.

Mr. Cuff (a shareholder) desired that the corresponding figures of the half of the previous year should appear in the report.

The Chairman said that they would consider the suggestion, but he saw certain objections against giving that knowledge, not to the company, but to the public. He could only explain these in private.

A vote of thanks to the Chairman was proposed by Dr. Trewhella, and seconded by Mr. Cuff, and the Chairman having briefly replied, the proceedings terminated.

The West Coast of America Telegraph Company, Limited.

THE eleventh ordinary general meeting of this company was held at Winchester House, 50, Old Broad Street, E.C., on Wednesday, at one o'clock, Mr. Alfred Marshall in the chair. The Secretary read the notice convening the meeting, and the report and accounts of the directors for the 12 months ending December 31st, 1887, were adopted as read.

The Chairman, in commenting on the report, said he could congratulate them that the company had done more satisfactory and more profitable business than in 1887, or in any previous year since its existence. The most prominent of the items on the income side were the earnings, which last year were £57,893 9s. 9d. This was almost entirely due to a larger traffic and the larger number of messages received and transmitted by the company, and to a small extent to the improvement in the rate of exchange. The exchange frequently varied to a considerable extent. In the year 1886 they were considerable losers by the exchange going down, but it had been rising again. So far as regarded the earnings, there was an increase in the interest account, which was due to a larger amount reserved to invest, and he hoped to see this item grow from year to year. The expenses incurred during the year had varied very little from those of previous years. In the West Coast expenses there was one item larger this year by nearly £1,000, namely, for salaries and wages. They had done more work and required more clerks; and they had a number of clerks who had done their duties well and their salaries had consequently been increased, and he thought that the well-earned increase had been to a great extent due the careful attention to their work. There was no doubt that their company maintained the reputation it had, and a good deal of the work it got was due in a great measure to the accuracy with which the work was done. The working expenses of the steamer were similar to those of last year. They had had to spend £1,700 more in repairing their cables, not a large amount, considering the long line they had had to deal with, namely, 1,700 miles. After deducting all the expenses, there remained a balance of £23,114 18s. 1d. to be brought forward. The auditor, in approving the accounts, mentioned the investment of £10,903 12s. 6d. Although this brought in nearly 8 per cent. on the capital, still, in a time of emergency, it would seem that this sum would hardly be available at a minute's notice. They might not be able to find those able to take these shares at the price paid. Near the close of the year 1887 they had sold the debentures at a profit, and invested them in securities which at any moment were convertible into cash, and gave them, he believed, a fair remuneration. In conclusion, he begged to propose the adoption of the report. They were, he said, only just beginning to get a firm hold of dividends. Last year they were only able to pay three per cent., and were adopting the policy of other companies in paying a dividend about the middle of the year, and making a further distribution at the end of the year. Although at the beginning of this year they could only pay two per cent. to shareholders, yet he thought it would please them better if they began at once to distribute the full amount of three per cent.

The adoption of the report was seconded by Mr. Thomas Fielden Campbell, and carried.

The retiring members of the Board, Mr. Alfred Marshall and Mr. Henry Roberts, were re-elected, as also Mr. J. Weise, of Messrs. Turquand, Young & Co., as auditor. After a vote of thanks to the chairman the meeting terminated.

The West India and Panama Telegraph Company, Limited.

THE directors of this company have submitted the accounts for the six months ending December 31st, 1887. The amount to credit of revenue is £44,945 14s. 11d., and the expenses have been £24,884 13s. 8d., leaving a balance of £20,061 1s. 3d., which, with the balance of £1,826 11s. 6d. brought from last account, makes a total of £21,887 12s. 9d. Of this sum the directors have placed £3,000 to reserve, leaving an available balance of £18,887 12s. 9d., with which it is proposed to deal as follows:—Payment of 10s. per share on account of arrears of dividend on the first preference shares, £17,281 10s.; balance to current half-year's account, £1,606 2s. 9d.

The traffic receipts for the six months show an increase of £3,623 12s. 3d., as compared with the corresponding period. The gross revenue is also augmented by the profit on the charter of one of the repairing ships to a connecting company, an improvement in exchange, and other exceptional causes.

The value of the cable used in the further repair of the original Jamaica-Porto Rico section, reported last November, amounts to £7,063, and has been, as on former operations on this section, charged to the reserve fund. The total expenditure for cable only, in restoring this important duplicate line, is £31,331.

As must always be expected from the exceptionally unfavourable nature of the West Indian seas, numerous interruptions of cables have occurred during the half-year, and the company's two ships have been frequently engaged. Owing to the duplication of the greater part of the system the communications with the colonies, except in one instance, have not been materially affected. All the cables are now in working order.

The company's ss. *Grappler* is now on her way to London to take out 258 knots of new cable which is being manufactured under contract.

Should the International Conference on the question of the bounties granted by Continental States to their sugar industries arrive at a satisfactory conclusion, it is hoped that the result will be beneficial to West Indian interests.

In accordance with the articles of association Messrs. Charles William Earle and William Ford retire at this meeting, and offer themselves for re-election.

Mr. John George Griffiths, the auditor, also retires, and offers himself for re-election.

The Consolidated Telephone Construction and Maintenance Company.—The directors of this company recommend the shareholders at the approaching general meeting to declare a dividend at the rate of £5 7s. per cent. per annum for the year ending March 31st, 1888, inclusive of the interim dividend paid in November last.

The Oriental Telephone Company, Limited.—At the adjourned meeting of the shareholders to be held on Friday, the 25th inst., the proposed dividend of 2½ per cent., free of income-tax, for the past year on the paid-up capital of the company, other than the vendors shares, will be again recommended by the directors.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 4th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,649.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 30th April are £3,988, as compared with £3,027 in the corresponding period of 1887. The January receipts estimated at £5,718 realised £5,955.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of April, 1888, amounted to £37,331, against £35,955 in the corresponding period of 1887—an increase of £1,376.

The Eastern Telegraph Company, Limited. The receipts for April, 1888, amounted to £51,382, against £43,136 in the corresponding month last year.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending May 4th amounted to £4,387.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending April 30th are £4,325.

NEW PATENTS—1888.

6237. "Improvements in jars or cells for primary or secondary electric batteries." A. MILLAR. Dated April 27. (*Complete.*)

6314. "Improvements in or relating to dynamo-electric machines." J. P. HALL. Dated April 28.

6322. "Improvements in galvanic batteries." P. R. DE F. D'HUMY. Dated April 28.

6344. "An improved means of conveying telegraph, telephone, and similar wires." W. DAVIES. Dated April 28.

6373. "Improvements in electric batteries." L. DILL. Dated April 30.

6382. "An improved electric automatic delivery box." W. MILLER. Dated April 30.

6414. "Improvements in lighting railway and other vehicles." I. A. TIMMIS. Dated April 30.

6416. "Improvements in galvanic batteries." L. HOPPE and G. HOPPE. Dated May 1. (*Complete.*)

6481. "Improvements relating to the electrical transmission of power, and to apparatus therefor." H. H. LAKE. (Communicated by N. Tesla, United States.) Dated May 1. (*Complete.*)

6502. "Improvements relating to the generation and distribution of electric currents and to apparatus therefor." H. H. LAKE. (Communicated by N. Tesla, United States.) Dated May 1. (*Complete.*)

6578. "Improvements in incandescent electric lamps." J. Y. JOHNSON. (Communicated by C. Philippart, France.) Dated May 2.

6613. "Automatic resistance for electric light circuits." S. MILLER. Dated May 3.

6614. "Improvements in the electrical illumination of clock dials and apparatus in connection therewith." E. G. CRAVEN. Dated May 3.

6627. "A combined generator of electricity and electric lamp." G. A. TABOURIN. Dated May 3.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

4884. "Improvements in dynamo-electric machines." J. PLATT, J. HOPKINSON, and E. HOPKINSON. Dated April 7. Relates to the construction of the armatures of dynamo machines, enabling them to carry greatly increased currents without undue heating, mechanical straining or disturbance of the magnetic field. In order to secure the bars against the great circumferential strain, the inventors provide the whole or portion of them with snugs which engage into metal discs which form a portion of the core of the armature. They make the end connections by means of copper strips which are attached to the ends of the bars, either by bending the strip beneath the bar or over the bar, or introducing it into a saw cut at the end of the bar, securing good contact either by soldering or drawing the bar and the strip together by means of a screw or screws screwing into a thread in the bar itself, or a thickened end of the strip, or a plate preferably of steel, beneath the end of the strip. When the bars are few in number two series of copper strips are used as has already been done, but when numerous it is found advantageous to use four series of strips. With powerful magnetic fields, bar armatures are liable to heating from local currents in the individual bars. The inventors obviate this by duly graduating the distribution of the field round the armatures so that its intensity shall not too rapidly increase or diminish at the edges of the pole pieces. This is accomplished either by means of extensions at the edges of the pole pieces or by causing the pole pieces more closely to approximate to the armature at the centres than at the edges. The claims are 5 in number.

1887.

563. "An improved dynamo-electric machine." H. H. LEIGH. (Communicated from abroad by Jean Louis Clerc, of Paris.) Dated January 13. 8d. Claims:—1. The method of manufacturing coils by winding an iron wire upon slotted mandrels of the desired outline, and the application of said method to dynamo-electrical apparatus. 2. The general construction of a dynamo-electric machine, substantially as described with reference to the figures. 3. The described commutator adapted to cut out the coils at the moment of reversal of current in combination either with electric generators or electric motors.

701. "Improvements in electrical meters." S. Z. DE FERRANTI. Dated January 15. 8d. Claims:—1. The employment in electric motor meters of an additional coil of insulated conductors, through which a current not forming any part of the current to be measured is passed continuously, for the purpose described. 2. Electric meters in which the pole pieces of the motor magnets are formed of laminated wrought iron, and are magnetised not only by the coil through which the current to be measured passes, but also by another coil or coils through which is led a current that forms no part of the current to be measured. 3. The construction of electric meters, substantially as described and illustrated. 4. The construction of electric meters, substantially as described and illustrated.

702. "Improvements in dynamo-electrical machines." S. Z. DE FERRANTI. Dated January 15. 11d. Claims:—1. A dynamo-electrical machine in which the armature is mounted on the end of an axis supported in a pair of bearings between which it has a driving pulley fixed upon it and in which the fixed magnets are divided into four sections which can be slidden away the one from the other, substantially as described. 2. In multiple magnet dynamos, that is, in dynamos in which more than two magnet poles are used mounting the armature on the armature axis outside the bearings in which the axis is carried. 3. Securing the coils of the armature each in a separate clamp and subsequently securing such clamp to the rim of the armature wheel with thick insulating material interposed between them, substantially as described. 4. Holding the armature coils in clamps each composed of a piece fitting to the interior of the sides and inner end of the coil and having projecting plates between which is held by rivets or other secure fastenings a block that fits to the exterior of the inner end of the coil and which projecting plates are formed with feet or flanges to facilitate their attachment to the circumference of the wheel, substantially as described. 5. Forming the armature coils from strips of metal, corrugated, dished, or hollowed, in cross section, substantially as described. 6. In double dynamos carrying the two armatures at the two ends of a shaft supported in two bearings and placing the driving pulley in the centre between the two bearings.

717. "Disc dynamo-electric machines and motors." W. B. SAYERS. Dated January 17. 8d. Claims:—1. In disc dynamo machines or motors, arranging the active portion of the armature conductors in a central position between sector shaped pieces of laminated or subdivided irons, as described and illustrated in the drawings. 2. Making the sector shaped pieces of laminated or subdivided iron of greater depth than the depth of the conductors and extending the projecting parts so as to overlap the same, substantially as described and illustrated in the drawings. 3. Making disc armatures for dynamo-electric machines or motors in which the active portions of the conductor pass through radial channels in or between the mass or masses of laminated or subdivided iron, substantially as described and illustrated in the drawings. 4. In disc armatures for dynamo-electric machines or motors, making the mass or masses of subdivided or laminated iron to overlap or cover the conductors so as to present to the polar surfaces of the field magnets a continuous or nearly continuous surface of subdivided or laminated iron, as and for the purpose described.

800. "Improvements in electric telegraph apparatus suitable for use to communicate between the bridge and the engine room of a steamship and applicable also to other uses." J. B. WILLIS. Dated January 18. 1s. 3d. Claims:—1. The combination, substantially as described, in an electric telegraph transmitter consisting of a contact making arm which as it travels opens and closes any electric circuit or circuits; a handle coupled with and actuating this arm, and a fly or equivalent control apparatus which regulates the speed of the arm independently of that of the handle, so that whether the handle be moved rapidly or slowly good contacts are obtained, as set forth. 2. The combination, substantially as described, in an electric telegraph receiver consisting of three electro-magnets symmetrically arranged around a circle, armatures to these magnets; a central axis with eccentric pin, connecting rods passing from the armatures to the eccentric pin, and gear connecting the central axis with an axis on which is an index or pointer showing the signals upon a dial, as herein set forth. 3. The combination, substantially as described, in electric signalling apparatus consisting of a transmitter which when operated by the movement of a handle transmits currents in succession through three line wires, and of a receiver in which are three electro-magnets connected with the line wires each to each, and armatures actuated by the magnets and an axis with eccentric pin and connecting rods symmetrically arranged around the axis and coupling each armature with the eccentric pin, as set forth. 4. The transmitter substantially as described. 5. The receiver substantially as described.

831. "Apparatus for converting alternating currents into continuous ones." M. IMMISCH. Dated January 19. 8d. Claim:—The means for converting alternating currents into continuous currents, consisting in including a motor and also an induction coil in the circuit of the generator, the secondary current from such induction coil being conveyed to one part of a commutator while the continuous current is collected from the other part thereof, such commutator being composed of two sets of segments arranged alternately and the segments of each set connected together, and two sets of brushes resting on such segments and also arranged alternately, those of each set being connected together, while a pair of brushes is provided, each one thereof being caused to bear on one of the hubs connecting each set of commutator segments, either the segments or the two sets of brushes resting thereon being actuated by the motor so as to shift same to the required extent in unison therewith, all substantially as specified.

2390. "Improvements in the electrolytical treatment of ores for facilitating the extraction and recovery therefrom of gold, silver, or copper, and in apparatus therefor." H. LIEPMANN. Dated February 15. 8d. Claims:—1. The process for treating powdered auriferous and other ores by means of chlorine gas, which is produced by electrolysing a suitable chloride solution mixed with the ore, air being simultaneously admitted thereto, all substantially in the manner described. 2. In the process for treating powdered auriferous and other ore by means of chlorine gas, which is produced by electrolysing a suitable chloride solution mixed with the ore, the application of air under pressure or vacuum, such air being forced or drawn into the ore, substantially in the manner described. 3. The combination of parts forming apparatus for treating powdered auriferous and other ores for the purpose of extracting the valuable metals therefrom, substantially as described and shown.

2517. "Improvements in the manufacture of telegraph poles, columns, pillars, flagstaffs, signal posts for railways, fence posts and other posts, rolls or rollers for various purposes, pipes or tubes for containing telegraph wires, railway sleepers, pillar letter boxes, urinals, chimney pieces, slabs for use in the construction of urinals and chimney pieces, and for pavements and stair treads and for other uses, tiles and slabs for roofing, sewer grids or gratings and other gratings, cellar plates, wheels, pulleys, sheaves for pulley blocks, dead eyes, buckets, coal boxes, and cocks or taps." D. WILSON. Dated February 17. 8d. Consists in filling the hollow part of telegraph poles, columns, pillars, flagstaffs, signal posts for railways, fence posts and other posts, and rolls or rollers for various purposes, so constructed with concrete or cement, or in forming the inner part solid, instead of merely coating the interior of the core with concrete or cement, as described in former specifications. The claims are 15 in number.

2959. "A new or improved combined bell push and automatic switch for electric alarms." H. C. CHOCQUEEL. Dated February 25. 8d. Consists in an apparatus to be combined with a battery and a suitable electric alarm for the purpose of sounding the said alarm in the case of various contingencies, the apparatus being used as a fire or burglar alarm, as an alarm for notifying excessive rise or fall of the level of water in boilers, or as an ordinary bell push, or for any other purpose to which it may be applicable. There are 2 claims.

3605. "Improvements in simultaneous telegraphy and telephony." C. SELDEN. Dated March 9. 8d. Consists in arranging a portion of the telegraphic circuit in multiple arc and interpolating electro-magnetic or other resistances which act as graduators in the various arc circuits. The claims are 8 in number.

CORRESPONDENCE.

Electricians and Electrical Engineers.

If your leaderette of last week is reliable, our language is deficient in adequate terms to express my opinion, *re* Mr. Stapylton and his lecture at Tunbridge Wells. The audacity of the man in talking such fearful bosh is only equalled by the apparent depth of ignorance on the part of his audience: else, would he have been tolerated?

This reminds us most forcibly of a matter which has been touched on before, viz., the necessity of instituting a distinction between the true and the sham electrician or electrical engineer.

One naturally turns to our Society of Telegraph-Engineers and Electricians as the best depository of the power of granting such distinction. The affix M.S.T.E. should denote something further than that the bearer is an annual subscriber of two guineas, and so on in proportion with the associates and students. For the very reason that they denote nothing, the society is held in but poor repute by "all sorts and conditions" of electrical workers, from the professor to the artisan. How many members, *e.g.*, could pass even the elementary papers of the City and Guilds Institute, in either of the branches of electrotechnics. I could mention some M.S.T.E's. to whom Ohm's law would be as intelligible as the inscriptions on Cleopatra's Needle.

A capite ad calcem, the society wants overhauling. Members of "ours" should wake up and force their council to seriously consider the question.

If the shams already in cannot be eliminated, they will at least fall off; and further influx can be stopped. There are obvious ways of bringing about such a condition of things: a condition which would bring incalculable benefit to the society and the profession generally.

W. Perren-Maycock, *A.S.T.E.*

May 5th, 1888.

Query.

I have before me two reports of the closing speeches of the discussion *re* A.T. and B.T. systems of distribution.

In your scientific contemporary *Engineering*, the two final speeches are put into the mouths respectively of Mr. Gee and Mr. Ruskin.

In your own paper of same date similar utterances are reputed as emanating from Mr. Frank King and Mr. Stuart Russell. Have these gentlemen different *aliases* for each paper? Are they mythical beings? Is the difference in nomenclature a simple reporter's error? If so, where does the mistake come in? In fact, who made the speeches is the query of

Puzzled.

May 7th, 1888.

[We believe the names given in the REVIEW are correct. At all events, both gentlemen spoke, but we do not know anything of the speeches of Mr. Gee or Mr. Ruskin.—EDS. ELEC. REV.]

Electro-Motors.

Having been reader and subscriber to your Journal for several years, and being greatly interested in electrical apparatus, I should be greatly obliged if you could inform me which is the best work to consult upon the theory and construction of electro-motors. Trusting I am not asking too much.

Wm. Greenhalgh.

May 7th, 1888.

[We can only call to mind three books bearing directly on the subject, viz.:—Those of Urquhart, Martin and Wetzler, and the Count du Moncel. It is probable that Kapp's book on the "Electrical transmission of energy" would be found the most useful.—EDS. ELEC. REV.]

Mr. Sprague on his Defence.

In line 51, first column, page 378, of your issue of April 6th, the word "maximum" should read "mechanical."

F. J. Sprague.

New York, *April 25th*, 1888.

Electropathic Belts.

From observations and articles contained in your journal during the past few months it is evident that you have not formed a high opinion of the value of Mr. Harness's electropathic appliances, although you imply that electricity may be of extreme use in certain cases when ordered by, and under the superintendence of, a qualified practitioner.

If electricity's curative powers can be of advantage to an invalid when prescribed by one doctor, why should they not be equally efficient in the hands of another? Mr. Harness is an M.D., and no doubt his knowledge of his profession is on a par with other men of the same standing. Your unfavourable criticism on his methods would appear to have been inspired or dictated by some persons in the same line of business, who have been distanced in the race towards success, or it may be that Mr. Harness's advertising proclivities —so contrary to the etiquette and practice of medical men in this country—have placed him beyond the pale of the recognised profession, but as an American licentiate, imbued with the noble purposes of aiding suffering humanity, he would naturally fly to advertising as the best means of disseminating a knowledge of the value of his electrical appliances; and it should be allowed that, repugnant as well he knew such a practice would be to the scientific feeling in Great Britain, yet he preferred to risk personal reputation in his endeavours to bring the greatest good to the greatest numbers, and be content to incur obloquy from all those on whose opinions he would set any store. The object of a doctor is to cure his patients, and the means of doing so are a secondary consideration. Instance a case in the Dublin hospital some time back where a lady came in complaining that she had swallowed a frog which wriggled down her throat and remained in her stomach; she could often feel it jumping about, and frequently heard it give a faint croak far down in her interior. She said the horror of the situation was driving her mad, and that if she were not relieved she would be compelled to commit suicide to save her life. The surgeon told her that he would administer an emetic if she would come the next day. The lady kept the appointment, and the emetic was taken with the usual effects, and in the basin she saw a fine healthy specimen of a frog. In the above case the cure was permanent; perhaps had she seen the attendant student slip the frog into the basin she might not have been so satisfied.

Possibly Mr. Harness has had similar experience, "Faith and Flannel" serving his purpose as a curative agent, and, if so, why not?

It would be unfair to blame him for restoring a patient to health, especially as the "Eminent Medical Electrician's" training must be counted far and away in advance of that of an ordinary member of the College of Surgeons. Brought up to a three-fold profession, he has gained success by his indomitable pluck and perseverance in utilising each separate profession conjointly. He qualified, he says:—

1. As an M.D. of Philadelphia, U.S.A., where the examination is extremely difficult to pass.

2. As a thorough electrical engineer in all its branches; the result of this electrical knowledge has led him to discard continuous and intermittent current systems, and to pin his faith on the short circuit system of electrical therapeutics.

3. As to this I am not quite positive, but have always understood that by the intense study of human nature obtained at a celebrated Irish castle, he finished his intellectual course by kissing the Blarney stone, gaining

thereby his almost unrivalled skill in commercial pursuits.

I think you will admit that your criticisms on the "Eminent One" have not been flavoured with your usual fair play or justice towards your neighbour.

Out of Harness.

Galvanic Belts and Electrical Quackery.

Many of your readers were no doubt delighted to learn that the cunning individual who appears to have tipped newspaper agents to enclose the report from the worthy pen of a barrister-at-law (one of the unemployed perhaps) on his visit to the well known establishment in Oxford Street, has been thwarted in his endeavour to turn your excellent report on the above subject into ridicule.

I feel more convinced than ever that the report and correspondence which recently appeared in the columns of your valuable paper in connection with this matter will do an infinite amount of good to the public at large. I trust the members of the Society of Telegraph Engineers and Electricians, to whom I have the honour to belong, will do their level utmost in the interest of science and honesty to rid this country of the notorious lunatics calling themselves medical electricians.

I enclose an advertisement respecting one of the wonderful electropathic belts which is said to cure all diseases incident to humanity, taken from the *Christian Herald and Signs of our Times*. Professed Christianity and questionable trading we frequently find go hand-in-hand now-a-day; this alas is too truly one of the signs of our times.

J. J.

Plymouth, Tuesday.

[Our correspondent appears to have mixed up two different notices, both of which, however, refer to the same general subject.—EDS. ELEC. REV.]

Telephonic Litigation.

It having come to the knowledge of the Equitable Telephone Association that the agents of the United Telephone Company are circulating reports to the effect that the association has not the intention nor the means of defending the action for infringement of patent that the United Telephone Company has thought fit to commence against it, the association asks the favour of your space to give these most unwarranted reports an unqualified contradiction. It also takes the opportunity of stating that not only has it the fullest intention of contesting the action to the utmost, but has also every confidence that it will be successful in upholding the freedom of its telephones.

A. A. C. Swinton, *Director,*
FOR THE EQUITABLE TELEPHONE ASSOCIATION, LIMITED.

May 4th, 1888.

Secondary Batteries.

I have noticed for some time past that much stress is laid upon secondary batteries by electricians engaged in installations of importance, so as to avoid any extinction of the lighting if it is found necessary to stop the machinery for a short time. I have noticed also in one of your leaderettes that you asked the managers of the E.P.S. Company whether, considering the importance of accumulators for tramcar service, they would not guarantee their wares for at least six months; but as yet I have seen no reply from the company. This question is of great importance, and, having watched the progress of secondary batteries from the time Mr. Volckmar had his little installation in Hatton Garden, I consider it very unfortunate that so very little has been done by the managers of that company to improve them, the plates being practically the same now as when the first were made, no attention having been paid to the weak points or to the manufacture. But what can be done to alter these plates, considering that it is apparently claimed by Mr. Sellon and one or two others that they have the sole right to manufacture accumulators? How is the matter to be dealt with? I notice that the E.P.S. Company have entered an action against the Union Company for infringement; is it to be taken for granted that the E.P.S. Company have the sole right to the use of lead and oxide of lead, thus shutting out any improvement in the accumulators not made by themselves? From what I know of the E.P.S. and other systems I have no hesitation in saying that accumulators can be made to last twice as long as those of the E.P.S., and practically at the same cost. There can be no doubt that the weak point in the plates is the falling out of the pellets, thus short-circuiting the cell and causing the plates to buckle. Now, this falling out can be entirely avoided, thus at once putting an end to the greatest evil they have to contend with. Therefore, I should like to ask you whether a change in form of plate would not be a good claim for a patent, seeing that metallic and peroxide of lead has been used for so many years past—in fact, before the Faure patents were taken out.

What do the E.P.S. patents consist of? Are they not concerning the form of plate and the method of their manufacture? As I well remember, when Mr. Volckmar came over here, there was no question as to what the plates were to be made out of; the question was how he should make them, and, finally, it was decided to cast them in chills in preference to punching holes in sheets of lead, and the form of holes then made was square, the hole being slightly smaller in the centre; there is the fatal mistake.

In view of the discussion now going on concerning "Transformers *v.* Accumulators," cannot something be done to decide this question without heavy law costs, and still have free trade in the manufacture of accumulators? That is, let the best article be put in the market, and in order to do this let all the rival makers be prepared to submit to certain tests by some unbiassed authority, so that we may go on no longer in a dog-in-the-manger spirit, as at present I fear is the case. Seeing that the E.P.S. Company is a powerful company, and law decisions being very expensive, it keeps back enterprise; and as it would be too long to wait for the supposed patents to die a natural death, can you give us any instance of accumulator patents previous to Sellon and Volckmar's, setting aside the Faure patents, the one that this question will have to be fought out on when the matter comes to an issue, and which I believe cannot be sustained? However, the sooner the matter is settled the better, as at present I know this is keeping back this branch of business, which assumes more importance every day.

Apologising for taking up so much of your valuable space,

J.

April 30th, 1888.

[We must leave our correspondent's queries to be answered by those who are specially versed in the points at which he aims, although it will require considerable ingenuity on the part of such as make the attempt to see the drift of some of the paragraphs, which appear terribly involved.—EDS. ELEC. REV.]

Accident at East London Junction, New Cross. Position of Block Instruments.

As it may be assumed that some of the adverse conditions enumerated in your comments on the above really existed, permit me to explain that the ringing keys and commutators were fixed immediately over the levers ready at hand, the semaphore instruments and bells alone being fixed at each end of the cabin in the same order as the four roads controlled by them, well in sight, an arrangement which has worked satisfactorily for the last 30 years. Personally, I approve of the localisation of all the apparatus over the levers, and have for some years past so fitted new cabins, and altered existing cabins as opportunity has presented.

W. Leonard, *Superintendent.*

South Eastern Railway,
Telegraph Department, Tunbridge,
May 8th, 1888.